# PRELIMINARY DRAFT

# County of San Luis Obispo Low Impact Development Handbook

Strategies for Post-Construction Stormwater Management in New Development and Redevelopment

**December 21, 2009** 

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Strategies for Post-Construction Stormwater Management in New Development and Redevelopment

This handbook is intended to provide guidance in using Low Impact Development tools and techniques. It should be viewed as a companion to San Luis Obispo County's Land Use Ordinances, which contain the detailed requirements for applying Low Impact Development to projects. Users of this Handbook should be aware that it has been developed using an iterative process that results from the cumulative effect of implementing, continuously evaluating, and making corresponding changes to a variety of technically and economically feasible tools. Therefore, it should be expected that this Handbook will be updated on a regular basis, and subsequently adopted by resolution of the Board of Supervisors. Users should consult the County's website or contact the appropriate County staff to ensure access to the latest information.

December 21, 2009

Funding for this project has been provided in part through an agreement with the State Water Resources Control Board. The contents of this document do not necessarily reflect the views and policies of the State Water Resources Control Board, nor does mention of trade names or commercial products constitute endorsement or recommendation for use. (Gov. Code 7550. 40 CFR 31.20)

# County of San Luis Obispo Low Impact Development Handbook

# Strategies for Post-Construction Stormwater Management in New Development and Redevelopment

#### **Table of Contents**

1.1 1.2	Purpose of the Handbook How to Use this Handbook
Chapt 2.1 2.2 2.3 2.4 2.5	er 2 Background and Regulatory Requirements The Impact of Development on Water Quality Local Environmental and Economic Impacts Stormwater NPDES Regulatory Requirements Low Impact Development Numeric Sizing Criteria
Chapt 3.1 3.2	The Development Review Process Ten Steps in the Project Application Process Step 1. Determine Project Designation Step 2. Gather Project and Site Information Step 3. Evaluate Best Stormwater Quality Approach Step 4. Select Source Control Measures Step 5. Implement Hydromodification Measures (Not Presently Required) Step 6. Select Treatment Control Measures Step 7. Prepare Application Submittals Step 8. Submit Final Stormwater Quality Plan Step 9. Establish Long-Term Maintenance Step 10. Construct Water Quality Features.
Chapt	er 4 Good Site Planning & Design Using LID Integrated Management Practices
4.1 4.2	Introduction to Good Site Planning & Design Planning Level Considerations Development Constraints and Opportunities Considerations

Parking Alternatives
Conserve Top Soil

Landform Grading Clustered Development

Chapter 1

4.3

Introduction

Street and Sidewalk Layout

Common Area Design Considerations

Vegetated Open Channels Multi-Functional Landscapes

Concave planted areas

Vegetated filter strips

Detention and retention basins

Curb and Gutter Alternatives Alternative Parking Surface Interceptor Trees

4.4 Building/Lot Level Design Considerations

Reduce Building Footprint/Foundation Excavation

Disconnect Impervious Surfaces

**Amend Soils** 

Harvest Rain Water

**Retention Grading** 

Rain Gardens and Bioretention Cells

Bioswales

Cisterns and Rainbarrels

Infiltration Trenches

Level Spreaders

Vegetated Roofs

# **Chapter 5** Pollution Prevention at the Source: Source Control Measures

- 5.1 Introduction to Source Control
- 5.2 General Structural Source Control Measures

Storm Drain Markers

Alternative Building Materials

Clean Water Segregation

Efficient Irrigation

5.3 Site-and Pollutant Specific Structural Source Control Measures

Fueling Areas

Maintenance Bays and Loading Docks

Trash/Recycling Storage Areas

Vehicle and Equipment Wash Areas

Material Storage Areas

Pools, Spas, and Fountains

Outdoor Work and Processing Areas

Pet Mitt Stations

# **Chapter 6** Hydromodification Control Measures

UNDER DEVELOPMENT

#### **Chapter 7** Treatment Control Measures

- 7.1 Introduction to Treatment Control
- 7.2 Treatment Control BMPs
- 7.3 Stormwater Pollutants
- 7.4 Treatment Control BMP Considerations

# **Chapter 8** Maintenance

- 8.1 Introduction to Stormwater Maintenance
- 8.2 Operation and Maintenance Plans
- 8.3 Transferring O&M Responsibility for Stormwater Facilities
- 8.4 Example Stormwater BMP Maintenance and Inspection Checklists

#### Glossary

# Appendices – Forms and Checklists for Project Application Submittals

# **Appendix A – Determine Your Project Type**

Stormwater Project Permit Designation Checklist Measures Homeowners Can Take to Reduce Stormwater Impacts

#### **Appendix B – Priority Project Applications**

Stormwater Quality Plan Application for Priority Projects and Required Checklists

# **Appendix C – Standard Project Applications**

Stormwater Quality Plan Application for Standard Projects and Required Checklists

# Appendix D – Low Impact Development Consistency Analysis

Summary of LID Scorecard Credits LID Scorecard

# Appendix E – Planting Guidelines

Plant List & Guidelines for Landscape-Based Stormwater Measures

# **Appendix F – Additional Resources**

Retention Grading Steps Reducing Impervious Surfaces Mimic Pre-Development Frequency and Duration of Events

# Ch 1: Introduction

# 1.1 Purpose of this Handbook

The purpose of this handbook is to provide guidance and direction on how to comply with Low Impact Development (LID) techniques. This handbook is intended for the use by developers, contractors, builders, designers, engineers, architects, planners, homeowners, and all others interested in learning how to address stormwater quality during the planning, design, and maintenance phases of a project. Project applicants should use this handbook to determine LID design features and post-construction stormwater management application and maintenance requirements for their new development and redevelopment projects. Please refer to Chapter 3 for the procedures and requirements on how to comply with Low Impact Development (LID) requirements.

#### 1.2 How to Use this Handbook

This handbook is a supplement to current County land use and development permit policies. It is meant to be used as a design aid for both the onsite and public improvement portions of projects; however, all improvements within the public right-of-way must be consistent with County Public Improvement Standards. Requests for adjustments to Design Standards, Standard Specifications or Standard Drawings for public improvements must follow the process identified in Section 1.2 "Design Adjustments" of the Public Improvement Standards. This process is also referenced in Land Use Ordinance Section 22.52.150B.1 and Coastal Zone Land Use Ordinance Section 23.05.048.b(1).

#### Overview

- Chapter 2 gives the background and regulatory requirements for stormwater quality and Low Impact Development (LID).
- Chapter 3 gives the steps for how to complete a successful project permit application.
- Chapter 4 provides guidance for planning and designing LID integrated management practices (IMPs).
- Chapter 5 provides instructions for stormwater pollution prevention Source Control Measures.
- Chapter 6 provides Hydromodification Planning Measures. This chapter is to be completed as part of the Central Coast Region's Joint Effort for hydromodification control. Following completion of the Joint Effort, this chapter will be adopted by the Board of Supervisors after a duly noticed public hearing.
- Chapter 7 provides instructions for Treatment Control Measures.
- Chapter 8 outlines requirements for long-term maintenance.

The appendices provide permit application forms, checklists, point scoring criteria, and plant selection guidelines to assist project applicants.

Since LID designs are highly site-specific, only broad considerations can be provided in this handbook. References are provided to assist designers find detailed information for LID designs.

# Ch 2: Background & Regulatory Requirements

# 2.1 The Impact of Development on Water Quality

Undeveloped natural landscape areas such as forests and grasslands act like sponges for rainfall. When natural landscape areas are covered with impervious (nonporous) surfaces like roads, parking lots, and roofs, this "sponge-like" function is lost and the amount of rainfall that can be absorbed is dramatically reduced. As shown in Figure 2-1, the percentage of impervious surface area of a site influences how much of a rain storm is infiltrated into the ground, evapotranspirated back into the atmosphere, or leaves the site as stormwater runoff.

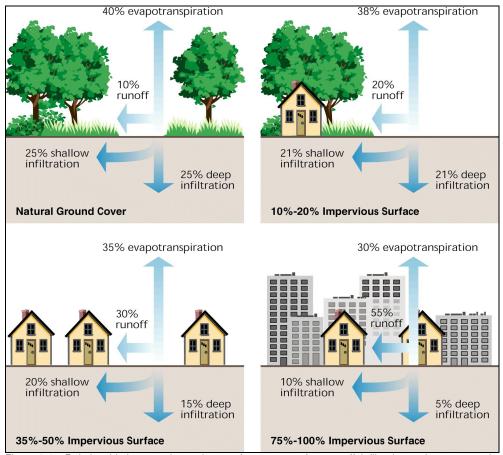


Figure 2-1 Relationship between impervious surface area, surface runoff, infiltration and evapotranspiration (Source: Stream Corridor Restoration: Principles, Processes, and Practices, FISWG 1998)

Increasing the amount of impervious surface area of a site can lead to a host of problems, including:

- Increased flooding frequencies and magnitudes;
- Increased erosion of streams and hillsides:
- Increased pollutant concentration levels in stormwater runoff; and
- Reduced groundwater recharge rates.

Development projects can also impact neighboring properties. Traditional stormwater management practices emphasize conveyance; that is, using street gutters, curbs, pipes and canals to remove water from the developed areas as quickly as possible and engineered flood control measures such as dams, dikes, levees, and detention facilities to offset the impact of development. This transfers the immediate problems downstream by increasing the amount of runoff leaving sites. The compound effect of increased impervious surface area with more efficient collection and conveyance systems is downstream flooding and erosion.

When runoff leaves a storm drain network and empties into a creek, the excessive volume and energy can scour creek banks, damaging streamside vegetation and harming aquatic habitat. that travels Runoff impervious surfaces often picks up pollutants that accumulated on that surface as a result of activities such everyday driving, maintaining vehicles and disposing of waste. washing cars and even walking pets. Polluted runoff may contain



Figure 2-2 Bank scour along San Luis Obispo Creek (Source: USFWS)

nutrients, pathogens, hydrocarbons, toxic organics, sediments, metals, trash, and debris. Increased creek and lake temperatures may result as the runoff picks up heat from paved surfaces. Pollutants and warmer water are carried to the storm drain system and are discharged directly to lakes, streams, and the ocean where pollutants can accumulate and degrade water quality and aquatic habitat for fish and wildlife.

The loss of infiltration from urbanization has also resulted in profound groundwater changes. As more surface area becomes covered with impervious surfaces, less water is able to seep back into the ground. Reduced groundwater recharge rates may result in lower base flows during dry weather as less groundwater available to move through the soil and into stream channels and aquifers.

To protect surface water quality and groundwater resources, new development and significant redevelopment projects should be designed, constructed, and maintained to minimize increases in runoff using Low Impact Development post-construction stormwater management strategies as the first choice alternative whenever possible.

#### 2.2 Local Environmental and Economic Impacts

Polluted stormwater has measurable environmental and economic impacts, including increased flooding, public health, harm to aquatic life, (including coastal shellfisheries), aesthetic impacts, impacts to tourism and recreation, and harm to community water supplies.

#### Flooding

According to the County Local Hazard Mitigation Plan<sup>1</sup> San Luis Obispo County has experienced severe flooding events that have resulted in loss of life and extensive property damage. Flooding can also inundate sewage treatment plants, prevent the safe passage of people and commodities, contaminate water supplies, damage agricultural resources, and result in accelerated rates of erosion.

#### Public Health

Stormwater can transport disease-causing bacteria, viruses, and protozoa. The County of San Luis Obispo Environmental Health Division consistently monitored 20 beach locations in 2007. Twenty percent of the samples taken during wet weather years received a grade of 'C' or 'D' according to Heal the Bay Foundation. The grade indicates the presence of total coliforms, fecal coliforms, enterococcus and fecal ratios observed in the overall number of samples taken. A complete listing of San Luis Obispo County health advisories is available on Heal the Bay's website<sup>2</sup>.

# Harm to Aquatic Life

Urban runoff can harm aquatic life in many ways due to changes in water chemistry and habitat loss. This includes:

**Nitrogen and Phosphorous** promote toxic and non-toxic alga blooms that harm aquatic life by depleting the amount of oxygen in the water and by decreasing light penetration for photosynthetic organisms. These pollutants also promote unwanted weeds.

Parking lots and roads can have an accumulation of **oil and grease**. The oil and grease forms a film over water which spreads and makes oxygen transfer difficult and is toxic to aquatic animals and plants.

**Metals** such as lead, copper, cadmium, zinc, mercury, chromium, selenium and nickel are toxic to fish and other forms of aquatic life and can cause genetic defects.

**Organics** may lead to human and animal reproductive abnormalities.

**Sediment** can reduce the suitability of creeks for spawning beds, decrease the light available for photosynthetic organisms and increase the transport of heavy metals and nutrients that adhere to the sediment particles.

Figure 2-3 Excerpts from MBEP (Source: http://www.mbnep.org/publications/)



The percentages on the map show how many samples exceeded the bacteria levels established for safe shellfish harvesting. This figure shows the approximate locations of established shellfish harvesting parcels. Harvesting is not currently allowed in portions of two parcels (shown in red on the map) due to elevated bacteria levels. The California Department of Health Services continues to monitor the areas surrounding the closed harvesting parcels to track the bacteria trends over time. The hope is that these parcels will eventually have clean enough water quality to resume shellfish operations. In the three active parcels (shown in green), growers are allowed to harvest shellfish during times of adequate water quality.

www.slocountyoes.com/lhmp\_bos.pdf
 http://www.healthebay.org/brc/annual/2007/counties/slo/analysis.asp

**Trash** in stormwater harms wildlife. The plastic loops that hold six-packs of beer or soda together can strangle gulls and plastic bags cause the death of marine animals through ingestion or entanglement.

Pathogens in stormwater also contaminate shellfish beds. Contaminated stormwater, along with pollution from other sources, have causes the closure of shellfish beds. According to the Morro Bay Estuary Program publication, "Estuary Tidings: A Report on the Health of the Morro Bay Estuary," two of the three harvesting parcels in Morro Bay have been partially closed to shellfish harvesting by the California Department of Health Services (DHS). DHS is responsible for ensuring that harvested shellfish are safe. DHS has concluded that bay waters are clean enough to support commercial shellfish operations in portions of the three parcels but require mandatory closures immediately following rainfall events due to high bacteria levels.

A key contributing factor is that levels of bacteria and viruses are usually 100 to 1,000 times greater in the bottom sediment, where shellfish live, than in the water above.

#### Aesthetic Impacts

The beauty of San Luis Obispo County's coastlines is world renown. The presence of cigarette butts, polystyrene cups, and other trash that storm sewers dump into the streams, lakes and the ocean creates an unwelcome eyesore. Sediment loads in these waters reduce water clarity.

#### Impacts to Tourism and Recreation

Potential human illness and aesthetic losses result in more than unpleasantness. Coastal and recreational tourism are major components of the local economy. On a typical weekend, many visitors look to the Central Coast as a getaway destination. If the degradation of the water bodies that accept contaminated stormwater is allowed to continue, these locations will be less attractive for visitors and may deter people from making San Luis Obispo County a vacation or travel destination.

# Harm to Community Water Supplies

Many groundwater basins within San Luis Obispo County are at or near overdraft. Excessive water withdrawals from our inland and coastal streams and basins will have potentially significant environmental impacts, including impacts to riparian habitats and altering of stream flows potentially affecting anadromous fish.

# 2.3 Stormwater NPDES Regulatory Requirements

To address the impacts of development on water quality, the National Pollutant Discharge Elimination System (NPDES) Small Municipal Separate Storm Sewer System (MS4) General Permit requires the County to develop and implement a Stormwater Management Program (SWMP) that describes Best Management Practices (BMPs), measurable goals, and timetables for implementation in the following six program areas:

#### 1. Public Education and Outreach

The County must educate the public about the importance of the stormwater pollution and the public's role in stormwater pollution prevention.

#### 2. Public Participation and Involvement

The County must comply with all State and local notice requirements when implementing a public participation and involvement program.

#### 3. Illicit Discharge Detection and Elimination

The County must adopt and enforce ordinances or take equivalent measures that prohibit illicit discharges. The Permittee must also implement a program to detect and eliminate illicit discharges.

# 4. Construction Site Stormwater Runoff Control

The County must develop a program to control the discharge of pollutants from construction sites greater than or equal to one acre in size within its permitted jurisdiction. The program must include inspections of construction sites and enforcement actions against violators.

# 5. <u>Post-Construction Stormwater Management for New Development and Redevelopment</u>

The County must require long-term post-construction BMPs that protect water quality and control runoff flow, to be incorporated into development and significant redevelopment projects. Post-construction programs are most efficient when they stress (i) low impact design; (ii) source control measures; and (iii) treatment control measures.

#### 6. Pollution Prevention/Good Housekeeping for Municipal Operations

The County must examine its own activities and develop a program to prevent the discharge of pollutants from these activities. At a minimum, the program must educate staff on pollution prevention and minimize pollutant sources.

This handbook addresses the Post-Construction Stormwater Management aspect of the Stormwater Management Program. For this program area, the County is required to:

- Develop, implement, and enforce a program to address stormwater runoff from new development and redevelopment projects that disturb greater than or equal to one acre including projects less than one acre that are part of a larger common plan of development that discharge into the municipal separate storm sewer system by ensuring that controls are in place that would prevent or minimize water quality impacts;
- Develop and implement strategies that include a combination of structural and/or non-structural BMPs;
- Use an ordinance or other regulatory mechanism to address post-construction runoff from new development and redevelopment to the extent allowable under local law;
- Ensure adequate long-term operation and maintenance of BMPs; and
- Comply with Attachment 4 of the General Permit. The complete text of Attachment 4 of the General Permit Attachment 4.<sup>3</sup>

The County must implement a post-construction program with design standards for the following types of discretionary development and redevelopment projects:

- Single-Family Hillside Residences;
- 100,000 Square Foot Commercial Developments;
- Automotive Repair Shops;

<sup>3</sup> Available at: <a href="http://www.swrcb.ca.gov/stormwtr/phase">http://www.swrcb.ca.gov/stormwtr/phase</a> ii municipal.html

- Retail Gasoline Outlets;
- Restaurants;
- Subdivisions with 10 or more housing units; and
- Parking lots 5,000 square feet or more or with 25 or more parking spaces and potentially exposed to stormwater runoff.

# 2.4 Low Impact Development (LID)

In contrast to traditional stormwater management approaches, the guiding principle of Low Impact Development is not conveyance. Low Impact Development (LID) uses a basic principle modeled after nature: Manage rainfall at the source using uniformly distributed, decentralized micro-scale controls. LID designs can reduce stormwater volumes, rates, pollutant loading, and downstream erosion associated with development while recharging the groundwater table.

The ability of LID to successfully mimic the site's predevelopment hydrology is a function of the region's climate regimes, the soil's ability to infiltrate runoff, the site's topography, the depth of the groundwater table, and the proportion of pervious area maintained on the site. While LID has the potential to reduce the impacts of development, it also can decrease the project's direct life-cycle costs by reducing the amount of infrastructure needed to convey stormwater and by decreasing the cost of maintaining stormwater infrastructure.

Ideally, upon development, an LID site would discharge and infiltrate the same volume of stormwater, at the same peak rate, duration and frequency, and maintain the same water quality that had been historically discharged from the site prior to development. In new developments and where possible in re-developments, LID focuses on site design. The project should:

- Minimize the impacts of increased stormwater runoff from impervious surfaces and land conversions by maintaining peak flow frequencies and durations of the site's predevelopment hydrologic condition;
- Retain and incorporate natural site features that promote infiltration of stormwater:
- Design the project to fit the terrain instead of grading the topography to fit the project's structures;
- Preserve existing drainage patterns, pervious areas, and sensitive habitat areas within the project limits;
- Minimize the extent of proposed impervious surfaces (roofing, parking lots, streets, etc.):
- Minimize the use of structural stormwater controls (pipes, inlets, etc.);
- Use multifunctional landscapes to infiltrate, store, and intercept as much runoff as possible and as close to the origin as possible; and
- Limit the connectivity of impervious areas.

Although all projects will be required to integrate LID concepts into project designs, it is recognized that not all sites will be able to effectively incorporate all LID practices. For instance, soil permeability, soil contamination, slope, and water table characteristics may limit the potential for local infiltration. Large urban projects with significant lot coverage may lack the area to offset their increased volume of runoff. The criteria for obtaining a LID waiver are provided in Chapter 3.

LID designs must be carefully integrated into projects with a thorough consideration of engineering and geotechnical limitations. LID is particularly well suited for the following project sites:

- Project sites situated in closed depressions;
- Project sites with permeable soil types;
- Project sites containing, situated adjacent to, or draining to wetlands, riparian areas, fish or wildlife areas and/or estuaries;
- Projects resulting in negative impacts caused by the increase in volume or rate of surface water leaving or arriving at the site;
- Project sites located in an area underlain by a critical aquifer recharge area; and
- Project sites with designated open space area requirements.

To adhere to the MS4 General Permit requirements and the County's sustainability goal of "Meeting the needs of the present without compromising the ability of future generations to meet their own needs," LID strategies have been incorporated into County policies and this handbook. Provisions have been included to waive the requirement where infeasible or impractical.

LID has been successfully applied to government, residential, commercial, and industrial development and redevelopment projects. In areas with low impervious values and high porosity soils, LID can be a cost-efficient and effective method for managing runoff and protecting the environment. In areas with significant amounts of impervious surfaces and low porosity clay soils, incorporating LID may increase project costs and may not be feasible or appropriate.

# 2.5 Numeric Sizing Requirements

The Central Coast Regional Water Quality Control Board recognizes that:

- It is cost prohibitive to maintain the pre-development hydrologic regime everywhere at all times and still meet current development demands; and
- Impacts to receiving waters are real and measurable.

To maximize the return on stormwater investment, numeric sizing requirements were strategically selected to minimize cost while achieving key watershed health criteria including all of the following:

- Establishing groundwater recharge volume goals;
- Maintaining peak runoff rates consistent with pre-development rates;
- Establishing treatment control standards (volume and rate); and
- Minimizing directly connected impervious areas.

Land Use Ordinance Section 22.52.110 and Coastal Zone Land Use Ordinance Section 23.05.040 et seq. require that the control of drainage and drainage facilities minimize harmful effects of stormwater runoff and resulting inundation and erosion on proposed projects, and protect neighboring and downstream properties from drainage problems resulting from new development. Where conflicts exist between the ordinances and the thresholds provided herein, the ordinances shall control.

#### Groundwater Recharge Volume

Ideally, projects would be designed to recharge groundwater supplies at the historical rate. Sections 22.52.140 (LUO) and 23.05.046 (CZLUO) require projects to mitigate the impacts on recharge caused by the reduction in the permeability of soil areas on the site with logical exceptions. While on many sites it is currently impractical to construct retention facilities of the size necessary to replace the storage lost to development; it is often possible to retain the majority of the smaller, more frequent storm events using LID designs. Therefore, projects should infiltrate the initial runoff of each storm event. *Note:* Additional points can be obtained by using multiple basins throughout the project site (see Appendix D).

Projects shall infiltrate the initial runoff of each storm based upon the annual average rainfall as follows:

Table 2-1. Depth of Storm to Be Retained Onsite Per Acre of Impervious Surface Area

AVERAGE ANNUAL RAINFALL FOR SITE LOCATION BASED ON COUNTY HISTORICAL RAINFALL DATA	24 HOUR RAINFALL DEPTH TO BE TREATED ONSITE PER ACRE IMPERVIOUS SURFACE AREA
Less than or equal to 15 inches per year	0.50 inches
>15 and less than or equal to 18 inches per year	0.75 inches
>18 and less than or equal to 25 inches per year	1.00 inches
Greater than or equal to 25 inches per year	1.32 inches

<sup>\*</sup>Based on 85<sup>th</sup> percentile storm depth calculated using available rain gage data

This goal is not additive (i.e. the retention basin volume requirements specified in Public Improvement Standards Section 5.2.2A. "Retention Basins" can be used to meet groundwater recharge volume goals), although distributed, small-scale retention systems are preferred over a single retention basin.

#### Peak Runoff Rate

To reduce channel and slope erosion, runoff from a site should be discharged at a rate and volume compatible with the capacity of the natural streams it discharges to.

Runoff rates from the site for storms up to the 50 year, 10-hour intensity and duration storm shall not exceed the pre-developed 2 year discharge rate at each of the historic discharge locations.

This goal is consistent with Land Use Ordinance Sections 22.52.110 through 22.52.150 and Coastal Zone Land Use Ordinance Sections 23.05.040 through 23.05.048. These sections require that proposed projects include design provisions to retain off-site natural drainage patterns and, when required, limit peak runoff to predevelopment levels. Additionally, this threshold is consistent with the detention basin volume requirements specified in Section 5.2.2B "Detention Basins" of the Public Improvement Standards. Specific projects may have unique attributes that necessitate no detention (such as projects where detention would exacerbate flooding) or that could require detention volumes greater than the amount

specified here (such as projects where discharge is limited based on downstream infrastructure that is unable to convey projected rates of runoff).

#### Channel Protection

Many channels receiving stormwater runoff are susceptible to degradation as a result of changes in the runoff and sediment regime due to the development tributary to the receiving channel.

The County of San Luis Obispo has several provisions to protect the downstream channel resources, including energy dissipation at discharge locations, detention and retention policies, peak runoff rate controls and creek setback criteria. However, the extended duration of discharge from detention basins has been attributed to adversely affect the shear stress of receiving channels. To compensate for this, detention facilities and receiving waters should be evaluated to determine if a multi-stage discharge outlet that would allow low flow discharges (i.e. 2 year peak runoff rate), intermittent flow discharges (5 or 10 year peak runoff rate) and high flow discharges (50 or 100 year peak runoff rate) would be appropriate.

The benefits associated with selecting a lower intermittent flow discharge design storm can decrease detention basin sizes, but also increase the risk of downstream flooding and therefore should be selected carefully.

It is recommended that project proponents discuss the appropriateness of multi-stage discharge outlets with the County Public Works and Planning and Building Departments early in the design process or at the pre-application meeting.

#### Treatment Control Standards

The need for treatment control is dependent on the designation of the project (See Chapter 3). If required, treatment control standards are either based on volume-based or flow-based treatment control Best Management Practices (BMPs).

The CCRWQCB requires Permittees to use Low Impact Development Integrated Management Practices (IMPs) to treat stormwater runoff where possible. Rainfall infiltrated into the soil (with proper pre-treatment), may be excluded from the volume and rate of runoff to be treated per this requirement.

The CCRWQCB will only allow conventional treatment control BMPs if the Permittee can demonstrate that the cost of incorporating LID is prohibitive because the "cost would exceed any benefit to be derived." (State Water Resources Control Board Order No. WQ 2000-11.)

The purpose of establishing a *volumetric* treatment control BMP is to provide confidence that volume-based treatment control BMPs are capable of capturing and treating a specified percentage of the annual runoff. This involves detaining the runoff for a duration long enough to address the pollutants of concern. The BMP detention time is either associated with the inherent infiltration rate of the soils on the site or a restriction applied to the BMP means of discharge (typically a pipe, plate or weir). Treatment control BMPs that use volumetric-based design requirements are listed in Table 2-2.

Table 2-2. Treatment Control BMP Minimum Detention Rates

VOLUMETRIC BMP (CALIFORNIA STORMWATER QUALITY ASSOCIATION BMP NUMBER)	TIME EMPTY (HOURS)	ТО
Constructed Wetlands (TC-21)	24	
Infiltration Basins (Retention Basins) (TC-11)		
Wet ponds (Retention Basins with permanent Ponds) (TC-20)		
Extended Detention Basin (TC-22)	48	
Media Filters (2 chambered: settling basin & sand / absorptive filtering media) (TC-40)		
Bioretention (TC-32)	72	

For projects proposing volumetric treatment control, a hydrograph analysis is required to demonstrate adequate detention times. Information on computing composite curve numbers to account for disconnected impervious areas and Low Impact Development design components will be provided in Chapter 6 of this handbook, upon completion of the *Joint Effort* led by the Central Coast Regional Water Quality Control Board (CCWRQB). Projects required to treat stormwater shall use the volumes generated using the stormwater depths provided in Table 2-1.

The purpose of establishing a *flow-based* Treatment Control BMP rate is to provide confidence that the flow-based treatment control BMP is able to provide sufficient treatment to the runoff prior to it leaving the site. This generally involves a minimum contact time and maximum velocity and depth. See individual BMP design guidance for specifics.

The peak flow rate shall be determined using the Rational Method: Q = C \* I \* A where:

- Q = Peak flow rate, cfs
- C = Runoff coefficient per Chapter 6
- I = 0.36 in/hr (based on Caltrans District 5 treatment intensity number for SLO County)
- A = Drainage area (in acres)

Additional information on treatment control measures is provided in Chapter 7.

#### Directly Connected Impervious Areas

To reduce adverse impacts to biological resources associated with surface water, directly connected impervious area should be minimized to the greatest extent possible.

Chapters 4, 5, and 6 provide techniques to disconnect directly connected impervious areas.

# Ch 3: Preparing Permit Applications

# 3.1 The Development Review Process

To comply with Federal and State NPDES stormwater regulatory requirements, the County has integrated post-construction stormwater management into the development review process. This chapter outlines the County's development review process and gives step-by-step instructions for how to prepare permit applications for new development and redevelopment projects.

Figure 3-1 illustrates the process for addressing stormwater quality requirements in permit applications.

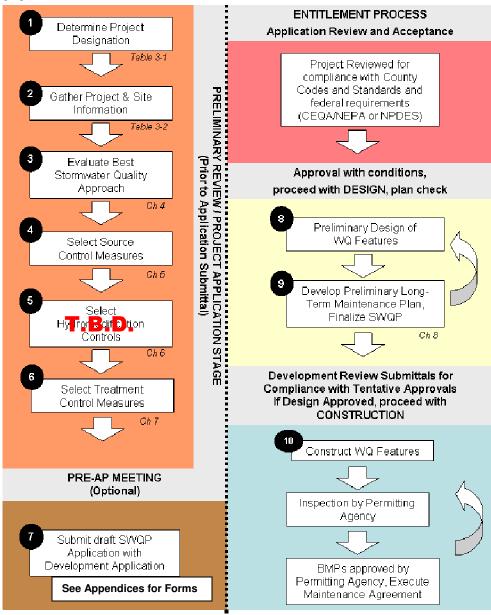


Figure 3-1: Process for Addressing Stormwater Quality Requirements during the Development Review Process

Stormwater management strategies should be considered early in site planning. Including stormwater management in the preliminary site plan can reduce overall project costs by minimizing rework and reducing infrastructure costs. Early planning enables more stormwater management flexibility.

The County's application process is designed to assure that post-construction stormwater controls are in place throughout the life of the project. The County requires additional documentation for erosion and sediment controls during construction.

# 3.2 Ten Steps in the Project Application Process

The ten steps outlined below must be followed to complete a successful project application. Subsequent chapters in this handbook provide more detailed instructions on how to accomplish each step.

# Step 1: Determine Project Designation

To determine if your project is a Priority Project, check the appropriate boxes from the table below:

Table 3-1. Project Permit Designation Checklist (also available in Appendix A)

İTEM	DEVELOPMENT AND REDEVELOPMENT CATEGORY	YES	No
1.	Single-family hillside residences on slopes greater than or equal to 10 percent		
2.	Commercial development where the land area for development is $\geq$ 100,000 square feet		
3.	Automotive repair shop		
4.	Retail Gasoline Outlet		
5.	Restaurant where the land area for development or redevelopment ≥or 5,000 square feet		
6.	Detached residential development of 10 or more units		
7.	Attached residential development of 10 or more units		
8.	Parking lots ≥ 5,000 square feet or with at least 25 parking spaces AND potentially exposed to stormwater runoff		
9.	Discharging to Clean Water Act 303(d) receiving waters, Sensitive Riparian Vegetation (SRV) or Wetlands (WET) Overlays		

If you answered **YES** to any of the above questions, your project is considered a **PRIORITY PROJECT** and will be required to submit a Stormwater Quality Plan (SWQP) and a Priority Project Stormwater Quality Application.

If you answered **NO** to <u>all</u> of the above questions and your project does not meet one of the established exceptions or exclusions **AND** your project disturbs greater than or equal to one acre, including projects less than one acre that are part of a larger common plan of

development or sale, your project is considered a **STANDARD PROJECT**. Standard projects must submit a completed Stormwater Quality Standard Project Application.

Projects that disturb less than one acre and are not part of the larger common plan of development or sale, and do not meet any of the Table 3-1 descriptions, may be considered **EXEMPT** from meeting the stormwater quality requirements specified in this handbook. Exempt projects are not required to follow the process outlined in Steps 2 through 10, however following these steps is recommended.

Post-construction stormwater controls are required for all projects. The required documentation and level of processing may vary based on the project designation: "Priority", "Standard" or "Exempt". Exempt projects are not required to follow this handbook. Please check with the Planning and Building Department to verify that a project meets the criteria to be considered "Exempt."

Consult with the Planning and Building Department staff to verify that your project meets the criteria to be considered "Exempt." Exempt project applicants are encouraged to implement practices that will reduce stormwater impacts associated with development. A list of suggested practices appropriate for homeowners is included on the "Measures Homeowners Can Take to Reduce Stormwater Impacts Form" found in Appendix A.

Maintenance and utility projects are also typically considered "exempt" from meeting the post-construction requirements specified in this handbook. Examples of exempt maintenance projects include routine overlays and slurry seals. Examples of exempt utility projects include the installation or repair of subsurface utilities or aerial utilities. Other types of exempt projects include installation of ADA ramps, small retaining walls, interior improvements and projects on private property that do not require a grading permit.

Industrial activities may be required to obtain an individual General NPDES Permit for Stormwater Discharges Associated with Industrial Activities<sup>1</sup>.

Appendix B includes the forms needed for Priority Project stormwater quality applications and Appendix C includes the forms needed for Standard Project stormwater quality applications.

#### **Step 2: Gather Project and Site Information**

Gather and evaluate the project and site information listed in Table 3-2. Table 3-2 provides a list of the most commonly needed information, its purpose, and its source. This list is preliminary and more specific information may be required prior to final design.

<sup>&</sup>lt;sup>1</sup> See State Water Resource Control Board web site at http://www.swrcb.ca.gov/water\_issues/programs/stormwater/industrial.shtml for more information on obtaining individual General NPDES Permit for industrial activities.

**Table 3-2: Commonly Needed Site Information** 

Table 3-2: Commonly Needed Site Information  CATEGORY DESCRIPTION PURPOSE SOURCE				
DATEGORY	DESCRIPTION		JOUNGE	
Hydrologic	Creeks, wetlands, watercourses, seeps, springs, ponds, lakes, areas of 100-year floodplain, any contiguous natural areas, include locations of run-on.	Development location should balance site constraints and opportunities (on the least sensitive portion of a site and conserving the naturally vegetated areas to minimize environmental impacts in general and stormwater runoff impacts in particular).	Site inspections, topographic survey and existing maps such as US Geologic Survey (USGS) quadrangle maps, Federal Emergency Management Agency (FEMA) floodplain maps, and US Fish and Wildlife Service (USFWS) wetland inventory maps.	
	Discharge	The stormwater plan should be designed	Receiving water quality Clean Water Act 303(d) list for the Central Coast Region	
Receiving Water Limitations	locations, including existing drainage, developed drainage and storm drain	considering the receiving water limitations based on the Clean Water Act	http://www.waterboards.ca.gov/water_issue s/programs/tmdl/docs/303dlists2006/epa/r3 _06_303d_regtmdls.pdf	
	connections, where applicable.	303 (d) list of impaired water bodies.	US Geologic Survey (USGS) quadrangle maps	
Topographic	Steep slopes, outcrops, or other significant geologic features	The project needs to comply with any local restrictions on development of steep slopes and soils that are susceptible to erosion. Avoidance of such areas is advisable in order to reduce stormwater impacts.	Site inspections, a topographic survey of the site, geotechnical report.	
Soil Types	Hydrologic soil groups and depth to groundwater	Determining the feasibility of onsite infiltration of stormwater.	Natural Resources Conservation Service (NRCS) Soils Survey maps <a href="http://websoilsurvey.nrcs.usda.gov/app/WebsoilSurvey.aspx">http://websoilsurvey.nrcs.usda.gov/app/WebsoilSurvey.aspx</a>	
Effective Impervious Area (EIA)	Existing and proposed impervious surfaces, e.g., roof, sidewalk, street, parking lots	To measure the relationship that exists between watershed health and the percentage of impervious surface area within a watershed.	Site inspections, a topographic survey of the site.	
Setbacks	Building, septic, open space, riparian, setbacks etc.	Development should be set back from creeks and riparian habitat as required by the local jurisdiction and the Central Coast Regional Water Quality Control Board.	County Dept. of Planning and Building County Code and Environmental requirements.  www.sloplanning.org Water Quality Control Plan, Central Coast Region (Basin Plan) http://www.waterboards.ca.gov/centralcoast/ BasinPlan/Index.htm	

CATEGORY	DESCRIPTION	PURPOSE	Source
Known or suspected Environment ally Sensitive Areas	Biological and culturally sensitive areas	Mature trees and native vegetation offer stormwater control benefits. Their preservation, along with other sensitive areas, is recommended.	County Dept. of Planning and Building County Code and Environmental requirements. www.sloplanning.org
Hazardous areas	Hot spots	Determine suitable BMPs.	Current SLO Co Hazardous Waste Site List, Special Studies, See Appendix H.
Pollutants of Concern (POCs) in Site Runoff	Existing POCs at site and possible POCs after project completion.	Knowing the target POCs at a site is necessary to designs appropriate postconstruction BMPs.	Project Site History (see above) Project Pollutant Generating Activities

Review the project and site information listed above to identify site constraints, the most appropriate stormwater treatment control measures, and opportunities to incorporate LID design features into the site and landscape design. Constraints might include impermeable soils, high groundwater, steep slopes, and geotechnical instability. Opportunities might include existing natural areas, localized depressions, and unbuildable portions of irregularly shaped parcels.

#### Step 3: Evaluate Best Stormwater Quality Approach

The project must demonstrate that it has included measures to reduce stormwater quality impacts. The best way to reduce stormwater quality issues over the life of a project is to employ good site planning techniques that:

- Minimize disturbance of natural drainage features and vegetation;
- Avoid sensitive areas and significant site features;
- Minimize the amount of directly connected and overall impervious surface area;
- Manage stormwater (quality and quantity) as close to the point of origin as possible;
   and
- Discharge site runoff at a rate and volume that maintains downstream receiving channel stability.

These strategies may decrease the project's retention or detention requirements as well as the need to incorporate costly mechanical, underground and/or "end-of-pipe" treatment systems into the project.

Table 3-3 is a checklist taken from the Project Stormwater Quality Application. The checklist can be used to determine if the project design reduces or eliminates stormwater quality issues. A **YES** response means that the item is addressed in the project. A narrative should be provided as part of the Stormwater Quality Application to discuss how, and when appropriate, where, the item is addressed in the plans. A **NO** response means the item in not addressed. A **NO** response will require a brief explanation for why the option was not selected. A **N/A** response means that the item does not pertain to the project.

Table 3-3A: Stormwater Approach Considerations

	Minimize Direct Stormwater Impacts – Refer to Section 4 and etion 6 of this Handbook for more information on how to do this	Yes	No	N/A
1.	Has the project been designed to avoid or reduce impacts to receiving waters and historic flow paths, to increase the preservation of critical areas such as floodplains, wetlands, and areas with erosive or unstable soil conditions?			
2.	For roadway projects, have structures and bridges been designed or located to reduce work in live streams and minimize construction impacts?			
3.	Is flow into natural open spaces conveyed in a non-concentrated manner?			
4.	Are disturbed slopes protected from erosion?			
5.	Have slope lengths or steepness been minimized by utilizing retaining walls, benches or terraces to shorten slope length?			
6.	Has top soil been preserved for re-distribution on disturbed slopes?			
7.	Have areas subject to compaction been minimized (i.e. minimize site disturbance, deep till areas compacted during construction or will soil amending be required)?			
8.	Have landscaped areas been used to minimize the amount of runoff?			

**Table 3-3B: Stormwater Approach Considerations** 

Refe	B. Minimize Directly Connected and Overall Impervious Surfaces - Refer to Section 4 and Section 6 of this Handbook for more information on how to do this			N/A
1.	Has the project been designed to minimize its impervious footprint (i.e. reduce street widths, street layouts, cul-de-sac design, parking, reduced setbacks and frontages)?			
2.	Can surfaces with greater porosity be substituted for impervious surfaces (i.e. replace traditional concrete and asphalt with permeable pavers or porous concrete)?			
3.	Where landscape is proposed, do rooftops, impervious sidewalks, walkways, trails and patios drain into adjacent landscape?			

**Table 3-3C: Stormwater Approach Considerations** 

Con	crease the Travel Time of Water off the Site (Time of centration) - Refer to Section 4 and Section 6 of this Handbook for e information on how to do this	Yes	No	N/A
1.	Have grades been flattened for stormwater conveyance to the minimum sufficient to allow positive drainage?			
2.	Are swales utilized in lieu of pipe or hardened channels (i.e., shallow grade swales with sand or gravel substrate below the vegetation to promote infiltration and storage)?			
3.	Is the post-development Time of Concentration (Tc) greater than the Tc for the pre-development condition?			

**Table 3-3D: Stormwater Approach Considerations** 

	D. Reduce Risk of Channel Erosion - Refer to Section 4 and Section 6 of this Handbook for more information on how to do this		No	N/A
1.	Has the project mitigated project-related increases in downstream velocity, volume and/or sediment loading?			
2.	Has the project addressed all project-related stream encroachments, crossings, realignments, or other hydraulic changes upstream and downstream of the project?			
3.	Have energy dissipation devices been included at outlets?			
4.	Are all transitions between culvert outlets/headwalls/wing walls and channel areas smooth to reduce turbulence and scour?			
5.	Are detention facilities included to reduce peak discharges?			

See Chapters 4 and 5 for a detailed description of potentially suitable site design and source control measures. LID criteria pertaining to hydromodification control will be developed through the Joint Effort amongst jurisdictions in the Central Coast Region. Once these criteria have been determined, they will be incorporated into Chapter 6 of this document by resolution of the Board of Supervisors after a duly noticed public hearing.

A pre-application meeting at this step is beneficial and is recommended.

# **Step 4: Select Source Control Measures**

Source control measures include activities, prohibition of practices, maintenance procedures, managerial practices, or operational practices that aim to prevent stormwater pollution by reducing the potential for contamination at the source of pollution. The goal of implementing source control measures is to:

- Prevent stormwater from contacting work and storage areas so it doesn't pick up pollutants; and
- Prevent pollutants from contacting surfaces that come into contact with stormwater runoff.

All sources of potentially significant post-construction pollutant loading shall be identified. The introduction of pollutants from these sources into stormwater and non-stormwater discharges shall be prevented or reduced to the maximum extent practicable.

Table 3-4 identifies the source control measures and when they are required.

**Table 3-4: Source Control Measures** 

Source Control Measure (Section Reference)	Requirements				
Water Quality Markers (5.2.1)	Mandatory on all projects with inlets connected to storm drain system.				
Alternative Building Materials (5.2.2)	Voluntary on all projects.				
Clean Water Segregation (5.2.3)	Voluntary on all projects, but doing so will reduce water quality treatment requirements associated with priority projects.				
Efficient Irrigation (5.2.4)	Voluntary on all projects.				
Fueling Areas (5.3.1)	Mandatory on all projects with fueling areas.				
Maintenance Bays and Docks (5.3.2)	Mandatory for 100,000 sf commercial developments with loading docks and retail gasoline outlets, automotive repair shops.				
Trash Storage Areas (5.3.3)	Mandatory for all Priority Projects except single family residences.				
Vehicle Washing Areas (5.3.4)	Mandatory for all Priority Projects except single family residences.				
Material Storage Areas (5.3.5)	Mandatory for all Priority Projects except single family residences.				
Pool/Spa/Fountain Discharge (5.3.6)	Clean out or designated land disposal area mandatory for projects with pools, spas or fountain discharges.				
Outdoor Work and Processing Areas (5.3.7)	Mandatory for all Priority Projects except single family residences with outdoor work or processing area.				
Pet Waste Management (5.3.8)	Voluntary on all projects.				

Chapter 5 provides instructions and acceptable design criteria for various site-specific source control measures.

The use of **runoff reduction measures** can reduce the amount of treatment control measures required for a site.

#### Step 5: Implement Hydromodification Measures

Step 5 is not a requirement at this time. Selection of appropriate LID Measures identified in Step 4 and Step 6 will satisfy the requirements until such a time as hydromodification control measures are adopted into Chapter 6 of this handbook by the Board of Supervisors after a duly noticed public hearing.

The goal of implementing hydromodification measures is to mimic a site's predevelopment balance of runoff and infiltration. Two components satisfy hydromodification requirements: volume control and peak flow rate control.

Volume control requires that the post-developed project <u>infiltrates</u> the same volume of water as the pre-development condition for the design storm. Once adopted, Chapter 6 will provide additional details on volume control BMPs.

Peak flow rate control requires that the post-developed project retains the pre-development peak discharge rate for the design storm. Once adopted, Chapter 6 will provide guidance on determining a site's pre-development condition and provide techniques that can be used to infiltrate, filter, store, evaporate, or detain runoff close to its source.

## Step 6: Select Treatment Control Measures

Stormwater treatment control measures are required for all Priority Projects. Treatment control measures are designed to reduce the concentration of pollutants in site runoff. The selection of a specific treatment control measure is based on a number of considerations, including:

- Type of pollutant targeted for removal;
- Receiving water limitations;
- Volume or flow rate of runoff to be treated;
- Amount of space available within the project;
- Site-specific conditions and associated limitations;
  - Slopes:
  - Depth to water table;
  - Depth to bedrock/hardpan;
  - Proximity to foundations/wells/septic systems; and
- Costs to construct and maintain.

Chapter 7 provides several tools to aid in selecting an appropriate treatment control measure based on the type of pollutants expected. In general, "end of pipe" treatment approaches are costly and maintenance intensive and are the least favorable option.

Applicants may request a waiver from the requirement to install Treatment Control Measures if they can provide an alternative compliance measure approved by the Director of Planning and Building and Director of Public Works, and also demonstrate that:

 The installation of stormwater treatment devices or flow control devices are impracticable for their particular site, or • The applicant will financially support an alternative project that will provide other equivalent water quality benefits.

The CCRWQCB prefers natural/passive water quality control BMPs over mechanical and underground options, but will allow for mechanical and/or underground options when passive water quality control BMPs have been found to be infeasible. Applicants must incorporate LID methodology into new and redevelopment projects unless they can demonstrate that conventional BMPs are equally effective, or that conventional BMPs would result in a substantial cost savings while still adequately protecting water quality and reducing discharge volume. In order to justify using conventional BMPs based on cost, the applicant must show that the cost of LID would be prohibitive because the "cost would exceed any benefit to be derived." (State Water Resources Control Board Order No. WQ 2000-11.)

Conventional site layouts, construction methods, and stormwater conveyance systems with "end of pipe" basins and treatment systems that do not address the changes in volume and rates of stormwater runoff and urban pollutants (including thermal pollution) do not meet MEP standards.

## **Step 7: Prepare Application Submittals**

All applicants are required to describe how existing runoff characteristics will be affected by the development project. The application shall contain measures for mitigating any adverse impacts to water quality. The submittal requirements vary based on the project designation.

Project Designation	Submittal Requirements
<u>Standard</u>	<ul> <li>√ Standard Project Stormwater Quality Application (Appendix C)</li> <li>√ LID Project Checklist (Appendix D)</li> </ul>
<u>Priority</u>	<ul> <li>√ Stormwater Quality Plan (Appendix B)</li> <li>√ Priority Project Stormwater Quality Application (Appendix B)</li> <li>√ LID Project Checklist (Appendix D)</li> </ul>

All Standard and Priority Projects must complete the LID Checklist, attached in Appendix D. This checklist is intended to allow the applicant to demonstrate how their project will meet the minimum requirements for LID design on their site. A project will be considered consistent with the LID Handbook if the project can achieve 14 credits (18 credits for rural development). Conditions of project approval will reflect the applicant's selected LID techniques.

#### **Step 7a: Priority Projects Submittals**

The Stormwater Quality Plan (SWQP) is a document that describes how existing runoff characteristics will be affected by development and contains measures for mitigating any adverse impacts to water quality. The SWQP shall identify constraints, expected pollutants of concern, and site design measures that minimize impervious surfaces and redirect runoff

from impervious surfaces to pervious surfaces, as well as source and treatment control BMP locations. In addition, the SWQP must be consistent with other application material (plans and reports). Things to consider when coordinating stormwater controls with other site construction plans include:

- Excess fill. Excavation for landscape detention areas, swales and other BMPs, as well as over-excavation/replacement of clay soils with more permeable soils, can alter the cut-and-fill balance for site grading. By considering this issue early in the site design, it may be possible to avoid excessive export of soil from the site.
- **Soil Compaction during construction**. Compaction from construction traffic can radically reduce the infiltration capacity of site soils. Construction staging plans should set aside and protect areas that will be used for infiltration BMPs.
- Building Drainage. Building codes require that drainage from roofs and impervious areas be drained away from buildings. The UBC also specifies minimum size and slopes for runoff leaders and drain piping. Detailed designs for BMPs locating in or on the building, or that may affect the building foundations, must accommodate these codes while also meeting the minimum requirements for detention or flow stated in this handbook.
- Control of Elevations. Distribution of overland flow to landscaped areas will require
  that grading and landscape plans be coordinated to provide adequate reveal (a drop
  required between pavement and vegetated areas to avoid ponding at edge of the paved
  surface) and prevent differential settling.
- Drainage Plans. Water quality measures are typically sized for low flow conditions.
   They must be able to incorporate or bypass flood flows. Drainage basin release rates must consider detention times and water quality sizing discharge criteria which are likely to be different from flood control sizing criteria.
- Landscape Plans. Bioretention areas, vegetated swales, wetlands, etc., require appropriate plant selection to function properly. Additionally, several of the source control BMPs require specific plant and irrigation selection.
- Organizing Traffic and Parking. Your stormwater plan may call for depressing landscape areas below paved areas rather that setting them above paved areas and surrounding them with curbs. Striping or bollards may be needed to guide traffic.
- Maintenance Procedures. Preservation of grades, drainage structures and landscaping, etc.

Stormwater Quality Plans (SWQPs) are required for all Priority Projects and shall accompany the Priority Project stormwater quality application. The SWQP must meet the design requirements of the County and include sufficient information to evaluate the environmental characteristics of affected areas, the potential impacts of the proposed development on water resources, and the effectiveness and acceptability of measures proposed for managing stormwater runoff. The information to be provided in the SWQP is provided in Appendix B.

The SWQP shall be prepared under the direction of a professional civil engineer registered in the State of California. The plan shall be stamped, signed and include a certifying statement indicating that all stormwater BMPs have been designed to meet the County's stormwater quality requirements.

A professional civil engineer must certify that the improvements conform to the approved plans before final inspection or sign off. The certifying engineer shall provide proof that they have been trained on BMP design for water quality not more than two years prior to the signature date. Training conducted by an organization with stormwater BMP design expertise may be considered qualifying. Examples of organizations deemed qualified to provide stormwater BMP design training include:

- California Stormwater Quality Association;
- · American Society of Civil Engineers;
- American Society of Landscape Architects;
- American Public Works Association; and
- California Water Environment Association.

If the plans include additional plants not listed in the County's approved plant list, landscape plans shall be prepared under the direction of a professional landscape architect registered in the State of California.

# **Step 7b: Standard Project "Application" Submittals**

In lieu of providing a Stormwater Quality Plan, Standard Projects may address post-construction stormwater management as part of the preliminary drainage report. Applications must also include the Standard Project Stormwater Quality Application in order for the report to be deemed complete.

Stormwater Quality Applications shall be submitted with the permit applications (e.g. land use permit, subdivision, grading permit, etc.) for the proposed project. Within 30 days of receipt of project applicant and Stormwater Quality Application (for both Priority and Standard projects), the application will be evaluated for completeness and, if necessary, additional information will be requested.

Once found to be complete, an environmental determination will be made on the application to determine if significant environmental impacts could potentially result from the proposed project. Mitigation measures may be required to reduce impacts to a level of insignificance, or an Environmental Impact Report may be required.

For discretionary projects, the Department will prepare a staff report to the Review Authority (e.g., the County Planning Commission, Subdivision Review Board) for the project's consideration. The Review Authority, based on County ordinances and policies, project facts, the environmental determination, and recommendations from other agencies, may approve, conditionally approve or deny the application. Pursuant to Sections 22.10.155.J (Land Use Ordinance) and 23.04.450.j (Coastal Zone Land Use Ordinance), the Review Authority may consider waiver or modifications of requirements under this Handbook. If the project is approved, proceed to Step 8.

# Step 8: Submit Final Stormwater Quality Plan

Standard design guidelines (Chapters 4, 5, 6 and 7) are provided in this handbook. Alternative designs will be considered if documentation is provided that includes supporting calculations and testing results that demonstrate equal water quality protection.

Priority projects will be required to implement all stormwater-related conditions of approval and mitigation measures associated with the approved project in a Final Stormwater Quality Plan.

Standard projects will document final stormwater related features in a water quality section in their final drainage report.

# Step 9: Establish Long-Term Maintenance

The long-term performance of BMPs depends on proper maintenance.

Prior to the issuance of building or grading permits (or prior to establishing a use) requiring stormwater management BMPs, the property owner(s) shall enter into a formal written stormwater BMP operation and maintenance agreement with the County<sup>2</sup>. The plan shall describe who is financially responsible for long-term maintenance. The required content of the Long-Term Maintenance Agreement is provided in Chapter 8.

#### Step 10: Construct Water Quality Features

While the owner is responsible for self-certification and inspection, the County will review water quality BMPs throughout construction. BMPs must be constructed according to the approved plans. BMPs relying on infiltration must be protected from contamination from construction site runoff.

2

<sup>&</sup>lt;sup>2</sup> Reference LUO Section 22.10.155G.7 and CZLUO Section 23.04.450.g(7)

# Ch 4: Good Site Planning & Design Using LID Integrated Management Practices

This chapter provides a guidance primer to assist applicants in integrating stormwater management and hydrologic goals and objectives into good site planning and design.

# 4.1 Introduction to Good Site Planning & Design

New development and redevelopment projects<sup>1</sup> that consider stormwater management early in the design process are much more successful in reducing the need for expensive stormwater treatment controls later. It is more efficient and cost-effective to prevent stormwater problems early rather than fixing them later.

Consider these fundamental Low Impact Design principles first to reduce project water quality impacts:

- Stormwater is rain, an important natural resource that is critically important for replenishing our streams, reservoirs, and groundwater supplies.
- LID post-development stormwater management systems use the natural features of the project site to mimic pre-development runoff characteristics (volume, rate, timing and pollutant loading).
- Using onsite storage, infiltration, transpiration and evaporation of stormwater reduces water quality impacts in contrast to discharging stormwater directly to water bodies.
- Non-LID structural or maintenance-heavy practices (such as detention basins, hydrodynamic structures, water quality filters, etc) should be used after all LID (nonstructural) integrated management practices have been fully explored and deemed technically infeasible, environmentally unsound, or too costly.

# 4.2 Planning Level Considerations

This section provides design guidelines to minimize stormwater impacts at the planning level.

#### Guiding Principles

When weighing potential development locations within a site, consider the constraints and opportunities for the site and adjacent properties. Ideally, the following considerations should be addressed:

- Follow the topographic contours to minimize soil and vegetation disturbance and the loss of topsoil and organic duff layer when laying out roads and lots.
- Avoid excessive grading, that is, grading beyond that which is necessary to construct the project.

<sup>&</sup>lt;sup>1</sup> "Redevelopment projects" are as defined in the Land Use Ordinance and Coastal Zone Land Use Ordinance. An example of a redevelopment project would be the creation or addition of at least 5,000 square feet of impervious area on a previously developed site.

- Limit removal of rock outcroppings, natural drainage courses, wildlife corridors, and mature native vegetation to the greatest extent possible.
- To reduce the extent of grading required and vegetation impacted, pads should not be built on compacted soil that is significantly raised above existing topography, unless no feasible alternatives exist given engineering constraints.
- Maintain buffers between developed areas and riparian corridors and shorelines.
- Cluster development areas to maximize the area available for stormwater infiltration and to reduce the effective impervious area of a project.
- Discharge impervious areas to vegetated areas.
- Surface infiltration systems are preferred over subsurface systems.
- Bioretention areas or vegetated channels designed with detention are preferred only where full infiltration is not feasible.

# 4.2.1 Development Constraints and Opportunities

#### Description

Carefully consider the optimal location for the building site within the project area. The building site location can influence the site's overall potential for erosion, habitat disruption, and ability to infiltrate water. Integrate the development project into the site rather than modifying the site to fit the proposed development project. Inventory the environmental features of the site and adjacent properties to assess how the project will impact or be influenced by the surrounding areas. To determine the project's constraints and opportunities, the analysis should consider both site and watershed-wide features.

#### <u>Applicability</u>

These procedures are most suitable for new development projects or projects seeking to expand.

#### Limitations

Redevelopment and in-fill projects may have limited opportunity to incorporate these recommendations.

#### Design Criteria

To the extent possible, development should be located outside natural protection areas (as identified in the preliminary site assessment) and within designated buildable areas to minimize soil and vegetation disturbance and to take advantage of the site's natural ability to store and infiltrate stormwater. The following design criteria are intended to help foster a development plan that is compatible with the site:

- Conserve natural areas, soils and vegetation, preferably in contiguous blocks or linear corridors.
- Drain runoff from impervious areas through vegetated areas before leaving the site.
- Avoid stream crossings for roads and conveyance systems whenever possible.

- Integrate small, dispersed bioretention areas to capture, store, and infiltrate stormwater on-site.
- Maintain pre-development flow path lengths, groundwater recharge rates and natural drainage patterns, whenever possible.
- Minimize soil compaction, where feasible.
- Minimize site disruption, where feasible.

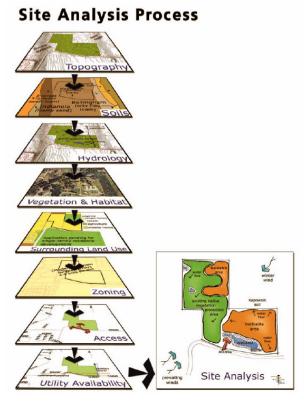


Figure 4.2.1-1 - Site Analysis Process (excerpted from Puget Sound LID Manual, graphic by AHBL Engineering)

#### **Process**

Develop a site constraints map that shows:

- Creeks, wetlands, watercourses, seeps, springs, ponds, lakes and areas within the 100-year floodplain, including existing drainage patterns including locations of concentrated run-on and runoff.
- Natural steep slopes, cliffs, outcrops, or other significant geologic features, as well as geotechnical hazard areas.
- Tree conservation areas (include tree species, diameter at breast height, canopy cover and condition of ground cover and shrub layer).

To determine the most suitable areas for development, you will also need to consider other constraints, such as visual, traffic, septic systems, easements, etc.

To receive an overview of the process and a checklist of information and materials you will need to provide, schedule a pre-application meeting with County planning staff.

Hydrologic soil groups and areas with high groundwater. Highlight the soils that provide the greatest opportunity for storage and partial infiltration.

 Existing imp	ervious	surfaces,	e.g., r	oofs,	sidewa	lks, stre	ets, and	l parking	lots.
Differentiate	betweer	n streets wi	th rate	es of	15,000	average	daily tra	vel (ADT)	and
streets with 25,000 ADT.									
 Archeologica	l (use	terminology	such	as	"Environ	mentally	Sensitiv	ve Area")	and

Archeological (use terminology such as "Environmentally Sensitive Area") and biological sensitive areas, including potential wildlife movement corridors.

\_\_\_\_ Existing fuel tanks (both on-site and within 500 feet of site).

Public and private wells and septic systems including leach lines (within 250 feet of the site).

Use the site information collected and design criteria to locate the most suitable areas for development on the site constraints map.

# 4.2.2 Landform Grading

#### Description

Landform grading is a technique that converts "engineered" slopes to stable, naturally functioning slopes that mimic nature. Concave slopes allow water and vegetation to concentrate at flow lines. Grasses and groundcovers are planted on the convex portions of the slopes. Landform grading is intended to reduce erosion potential, runoff, and water quality degradation associated with land form alteration (grading).

# <u>Applicability</u>

Landform grading is suitable on all development projects that require significant cut and fill and where the average natural slope is ten percent or greater.

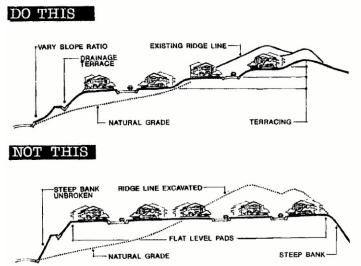
#### Limitations

Grading must be consistent with geotechnical engineering recommendations.

#### Design Criteria

The overall grading of the project should work together with the surrounding topography, existing vegetation, circulation, and land features as well as other elements of the total project site to minimize the erosion potential, runoff and water quality degradation associated with land form alteration (grading). Grading proposals should conform to the following standards:

 In lieu of one large pad, development proposed for hillsides should use smaller pads gradually terracing up hillsides, where feasible.



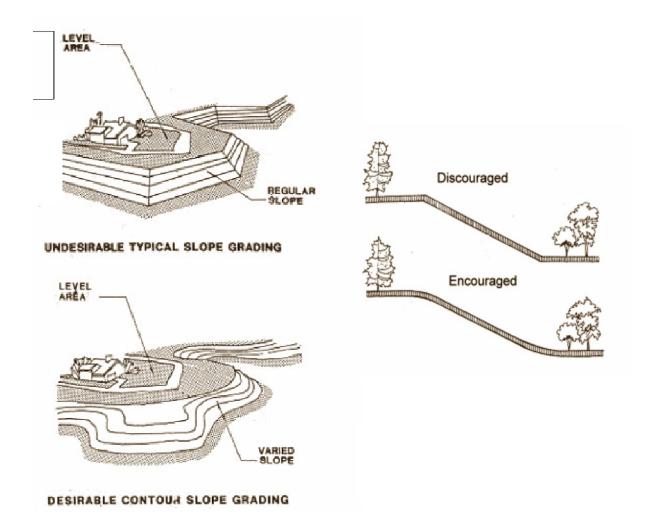
Prerequisite A.2

PRIORITY: Required STANDARD: Required

Source: White County Sample Mountain and Hillside protection ordinance

• The use of long, continuous slopes with sharp, angular forms should be avoided. Slopes should retain a natural appearance.

- Hillside development should conceal graded slopes and retaining walls, where possible. Retaining walls and all significantly graded slopes should be planted.
- Pads should not be built on compacted soil that is significantly raised above existing topography, unless no feasible alternatives exist given engineering constraints.
- Avoid creating directly connected impervious areas, where possible.
- Require compacted soils in areas receiving sheet flow runoff (such as yards, down slope of downspouts) be disked and amended with loam prior to planting.
- Ensure that concentrated flow paths have stable outlets able to handle the water expected to be received.



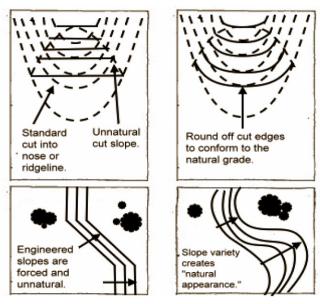


Figure 4.2.2-2 (Excerpted from City of Encinitas Grading Ordinance)

# **4.2.3 Clustered Development**

Credit B.4.1 / B.4.2 / B.4.3 1-3 Credits

## <u>Description</u>

Clustered development maximizes open space and encourages site planning sensitive to the natural characteristics of the land. It also helps reduce the effective impervious area associated with development.

#### Applicability

Clustering may be used with nearly all development projects, but is most effectively used in the development of subdivision of larger parcels, where concentrating the allowable development on only a portion of the site allows preservation of sensitive resources. Incentives such as smaller lot size or bonus density increases over that permitted in the zone are often components of cluster development.

#### <u>Limitations</u>

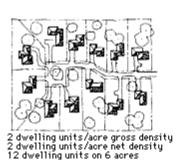
Grading plans must comply with geotechnical engineering recommendations.

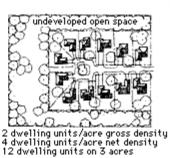
# Design Criteria

To the extent possible:

- Preserve areas within or adjacent to identified sensitive areas (steep slopes, wetlands, riparian corridors, etc) or with high infiltration capacity.
- Run-on to preserved areas should mimic existing natural drainage patterns (i.e. if run-on formerly was conveyed to an area under sheet flow conditions, sheet flow conditions shall be maintained to the preserved area even after development of the surrounding area).
- Bioretention and open swale systems are integrated into landscaping.

- Road and driveway stormwater are dispersed to adjacent open space and landscaped areas.
- Pre-development flow path lengths in natural drainage patterns are maintained, or lengthened as necessary to prevent an increase in runoff rates.
- Native vegetation and soils are preserved or enhanced to disperse, store and infiltrate stormwater.







Sources for Figures 2, 3, 4, and 5: Protecting Water Quality in Urban Areas: Best Management Practices for Minnesota, Ch. 3, Minnesota Pollution Control Agency, Division of Water Quality, St. Paul, MN, Oct. 1989. Excerpted from City of Chesapeake, VA –Design Guidelines Handbook

# 4.2.4 Parking Alternatives

Credit B.2.1 1-2 Credits

#### Description

Nearly all rainfall falling onto parking areas constructed of impervious surfaces (asphalt and concrete) will runoff the site. As runoff travels over the parking surface, it picks up sediment, dust, oils and greases. The smooth surface of the pavement increases the rate and volume of runoff.

Reducing parking standards not only reduces impervious surface area, but also reduces parking related development cost and is intended to assure that the number and type of parking spaces specified does not exceed the number of parking spaces needed for the project.

#### Applicability

Parking alternatives are appropriate for adjacent developments with different peak demand periods and can be effective in compact and/or high density communities where dwelling units are within walking distance to transit stops and services.

# **Limitations**

Reduction or elimination of off-street parking requirements for one neighborhood or commercial center may increase the parking density of adjacent neighborhoods or commercial centers. Shared parking agreements must include a contingency plan to accommodate changes in ownership, operations or other uses that might increase the parking demand in the future.

## Design Criteria

- Parking requirements should reflect projected demand for parking and include an analysis of the potential impact of spillover parking on adjacent areas.
- Minimize off-street parking to meet or decrease Title 22 and 23 parking ratios. If
  - additional parking beyond the parking ratios is permitted, consider using pervious materials or storied parking garages.
- Maximize the use of compact car spaces.
- Use parking garages where feasible.
- Use pervious parking surfaces.
- Use legally binding shared parking agreements when adjacent proposed land uses have peak parking demands at different times of the day or week.
- Incorporate bioretention areas into parking lots.



Credit A.1.1 (1-2 Credits) Credit A.1.2 (1-2 Credits)

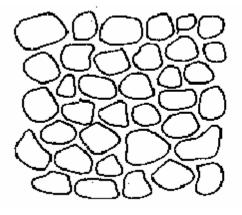
http://www.slocountyhomes.com/uploaded\_images/100\_0210-726655.JPG

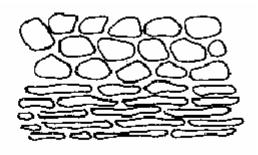
# 4.2.5 Conserve Top Soil

#### Description

Undisturbed top soil has characteristics (texture, structure and biology) well suited for infiltration and water treatment. When soil is compacted or otherwise disturbed, it can loose its texture, structure and biology.

The soil on the left has pore spaces indicate of healthy soil that allows the efficient exchange of air and water. The soil on the right is compacted and will restrict root growth, limit infiltration and air circulation in the soil.





Source: http://www.dpi.nsw.gov.au/agriculture/resources/soils/structure/compaction

# Applicability

These procedures are suited for most sites.

#### Limitations

None

### Design Criteria

To the extent possible,

- Top soil to be conserved in place shall be identified and delineated on the plans and in the field using orange construction fence around areas to be protected from heavy equipment.
- Areas requiring cuts shall have the native topsoil removed (to the depth of the top soil) and stockpiled for replacement to the surface of the area cut or used elsewhere on the site to amend areas with deficient topsoil. Stockpile depths shall not exceed 3 feet if left in staging area for more than 6 months. Stockpiled top soil shall be spread onto cut slopes that have been tilled to a depth of 6 inches. The top soil shall be placed in lifts not exceeding 1 foot. Compaction should be limited to the density of existing, undisturbed areas.
- Natural resource areas that have been disturbed may need to be replanted with native trees and vegetation.

## References:

http://www.cabmphandbooks.com/Documents/Construction/EC-2.pdf

# 4.3 Common Area Design Considerations

The purpose of this section is to provide design guidelines for common areas. Common areas are usually maintained by a public agency, assessment district, or Home Owners Association. The following guidelines are intended to minimize stormwater impacts by incorporating stormwater friendly design principles into project plans.

# **Guiding Principles**

- Reduce overall street lengths and widths in street and sidewalk layouts.
- Convey drainage in open swales rather than in closed conduits.
- Use medians, bulb-outs, cul-de-sacs and roadside swales to limit continuous flow paths over impervious surfaces.
- Use alternative pervious surfaces for driveways, alleys, low volume residential roads and parking lots rather than traditional impervious surface materials.
- Minimize hardscaping by including sidewalks on one side of the street only and/or constructing sidewalks using pervious materials.
- Design stormwater outlets properly to prevent erosion.
- Cluster residential parking areas to maximize area available for non-structural stormwater conveyance (roadside swales).
- Plant trees throughout commercial parking lots, along street frontages, and on residential lots.

# 4.3.1 Street and Sidewalk Layout

# **Description**

Streets and roads are among the largest contributors to polluted stormwater runoff. LID practices reduce impervious area, maximize stormwater infiltration, and reduce pollutant loads.

Subdivision street and sidewalk layout influences the amount of impervious area significantly. As shown below, the overall impervious area associated with streets is significant. Various street configurations can also influence the connectivity of a neighborhood and the land available for open space.

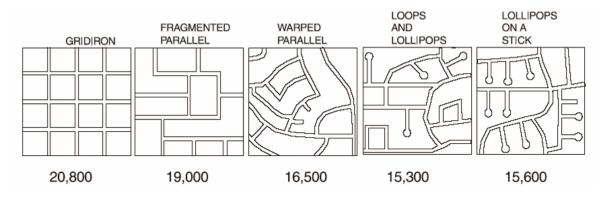
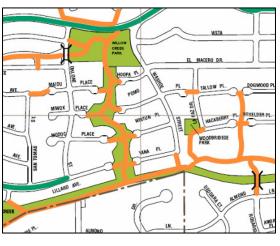


Figure 4.3.1-1 Comparison of linear feet of pavement associated with various street layout alternatives. Excerpted from NEMO LID Handbook, originally adapted from ULI 1980

As shown in the City of Davis Bike Map, pedestrian and recreational facilities can also be used to meet stormwater and open space goals.





Credit B.4.3
1 Credits

Source: City of Davis Bike Map

# **Applicability**

These procedures are suitable for all development projects, but must be weighed against other considerations, such as the amount of earthwork required or specific traffic patterns to the site and surrounding areas.

#### Limitations

The roadway system must follow County Improvement Standards and safely accommodate all users of the road including pedestrians, people requiring mobility aids, bicyclists, drivers and passengers of transit vehicles, trucks, automobiles and motorcycles. Requests to incorporate LID will require an exception in accordance with Section 1.2 "Design Adjustments" of the Public Improvement Standards. The minimum street widths for a particular project may be limited based on average traffic daily counts and/or terrain and size of vehicles requiring regular access to the site.

#### Design Criteria

To the extent possible,

- Provide pedestrian and bicycle path connections to encourage walking and cycling and increase access without adding significant impervious areas. Plot a likely "paths" exhibit using the lot layout to map pedestrian routes to schools, bus stop and neighborhood services.
- Reduce the length and width of residential streets by reviewing minimum lot widths and exploring alternative street layouts.
- Street location considerations should include natural drainage patterns and soil permeability and must provide for large vehicles, equipment, and emergency vehicles access where applicable.

See the Public Improvement Standard Plans for minimum street widths for public roads and adjustment procedures. Discuss options for reduced street widths with the applicable fire agency.

## References:

http://www.completestreets.org/resources.html http://www.walkinginfo.org/index.cfm

# 4.3.2 Vegetated Open Channels

#### <u>Description</u>

Vegetated open channels are shallow channels meant to blend into surrounding landscape while conveying stormwater runoff short distances, typically ending at a bioretention facility, detention or retention basin or to a level spreader. This design technique should be considered instead of storm drain pipes at locations where storm drain pipes are proposed.



Credit D.1 (1 Credit)

www.omafra.gov.on.ca

# **Applicability**

This practice should be considered on all projects with ground slopes less than 4 percent. Tributary areas to open channels may be limited to allow runoff to be conveyed in a non-erosive manner.

#### Limitations

Structures and pavements adjacent to vegetated open channels may require a moisture barrier to preserve their integrity. Pipe systems may be more appropriate on sites with steeps slopes or highly erodible soils. Depending on the tributary area, a high-flow drainage system may be necessary. Vegetated open channels are not appropriate at locations with high ground water table elevations. Grassed swales without underdrains may result in soggy, wet areas conducive to mosquito breeding.

#### Design Criteria

To the extent possible,

- Channels should be sized to maintain a low velocity during small storms and to accommodate secondary design storms (see Public Improvement Standard 5-1) without significant erosion or re-suspension of accumulated sediment.
- Channels should have shallow depths and gentle side slopes.
- Swales should be planted with native vegetation. The vegetation of channels located along a roadway and at driveways must conform to County Standard Plan A-5a and A-5b (no greater than 30 inches).
- Check dams may be used to increase detention time, slow the velocity of runoff, and allow sediment to settle out.
- Use pipe or subsurface stone recharge bed to accommodate driveways and intersecting roads. Infiltration is promoted by elevating the outlet of the channel above the flow line of the pipe or subsurface stone recharge bed.
- To obtain water quality treatment control benefit, the water surface elevation associated with water quality storms must not exceed the vegetation height AND the runoff should remain in the channel for a minimum of 10 minutes.

Channels adjacent to roads may require pavement edge stability measures (such as a flush curb), to keep the pavement edge from spalling.

#### References:

http://www.stormwatercenter.net/Handbook Builder/Performance%20Criteria/Open%20Channels.htm

www.cabmphandbooks.com/Documents/Development/TC-30.pdf http://www.epa.gov/owm/mtb/vegswale.pdf

# 4.3.3 Multi-Functional Landscapes

Areas proposed for landscaping can also be used to filter, treat and infiltrate stormwater runoff. Often this requires an interdisciplinary team to ensure the functionality of the landscaped areas. This team

Credit B.3 1-3 Credits

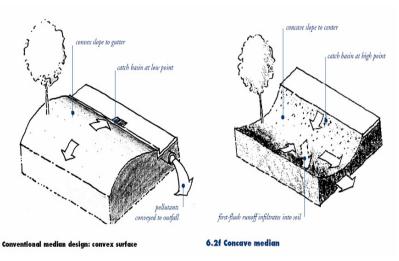
should be assembled early in the design process and consist of geotechnical engineers, landscape architects, architects and civil engineers.

This section includes LID practices that can be implemented in common areas or private yard areas to meet diverse functional needs.

# 4.3.3a Concave planted areas

#### Description

Most vegetated areas in parking lots, along roads or in landscaped medians can be designed reduce to the overall amount of runoff (and treatment required for that runoff) that leaves a site simply by using concave rather than raised landscaped areas. Concave landscape areas reduce overall effective impervious area, treat first flush runoff, and recharge aroundwater supplies locations where site engineering or subsurface soil conditions allow infiltration.



Start at the source.

### Applicability

This practice is suitable for all planted areas within roadway medians, parking lots islands and at the center of cul-de-sacs, with planting widths greater than 2 feet. It also applies to locations where retention/detention basins are necessary.

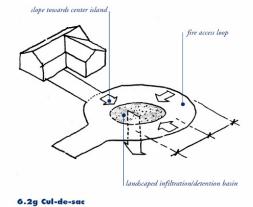
#### Limitations

Structures and pavements adjacent to concave medians may require a moisture barrier to preserve their integrity. Depending on the tributary area, a high-flow drainage system may be necessary.

#### Design Criteria

To the extent possible,

- Concave, planted areas are favored over impervious or convex planted areas.
- Overflow drains or paths are placed strategically to allow some of the stormwater to percolate into the soil.



If necessary, replace existing soil with engineered soil mixtures designed to enhance retention and pollutant breakdown.

#### References:

http://scvurppp-

w2k.com/pdfs/0203/c3 related info/startatthesource/Start At The Source Full.pdf

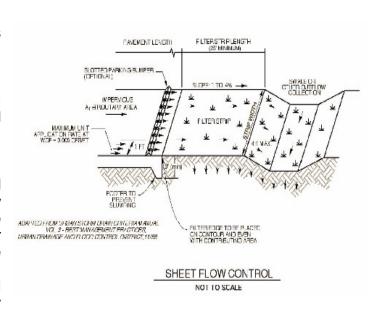
# 4.3.3b Vegetated Filter Strips

#### Description

Filter strips are vegetated areas that are situated between an impervious area and a location where runoff will leave the site. The vegetation (typically grass) serves to slow runoff velocities and filter out pollutants.

### Applicability

This practice should be considered on projects that receive sheet flow runoff and room available to provide at least 25 feet of filter strip slope length. The width of the filter strip should extend the length of the pervious area or level spreader tributary to it. Tributary areas should be less than 5 acres.



#### Limitations

Filter strips are not appropriate for use on unstable or steep slopes. Runoff with high contaminate levels should be treated prior to discharge over a filter strip.

# Design Criteria

- Filter strip slope should not exceed 6%. Slopes between 2 and 4% are more ideal. Slopes less than 2% may create mosquito habitat.
- Slope should be disked to a depth of 6 inches to incorporate topsoil for plant growth.
- Strips should not be overly long (which tends to concentrate runoff).
- The top and toe of a filter strip should be level to prevent erosion and encourage sheet flow.
- Benching can be used in conjunction with level spreaders to restore sheet flow when greater filter strip lengths are required.

### References:

See California Stormwater BMP Handbook Vegetated Buffer Strip Treatment Control Fact Sheet at <a href="http://www.cabmphandbooks.com/Documents/Development/TC-31.pdf">http://www.cabmphandbooks.com/Documents/Development/TC-31.pdf</a>

### 4.3.3c Detention and Retention Basins

Shallow retention and detention basins may be suitable as playgrounds or picnic areas.

#### <u>Description</u>

Detention basins temporarily store stormwater runoff and slowly release it through an outlet (control structure).

Retention basins temporarily store stormwater runoff until it can be infiltrated into the ground.

### **Applicability**

This practice should be considered on all projects with the need to maintain pre-existing peak flows (detention) or pre-existing volumes (retention). Shallow, multi-functional basins are most appropriate for small tributary areas.



Small multi-functional detention area at Dove Creek (Atascadero, CA). Source Wallace Group.

#### Limitations

Retention basins must adhere to County Public Works requirements.

Neither type of basin is appropriate for locations with steep terrain. High ground water elevations reduce the effectiveness of retention basins.

# Design Criteria

- Distributed small basins are preferred over a single, large deep basin.
- Pre-treatment is required to prevent significant sediment loads from entering basins.
- Basins should completely drain within 72 hours (but no longer than 7 days) after the completion of a storm event to minimize the risk of mosquitoes. Under drains may be used in areas with inadequate infiltration rates.
- Basins not fenced and with public access must have 5:1 or flatter side slopes and ponding depths not greater than 2 feet.
- Forebays and microbasins may improve the water quality treatment capacity of the basin
- Basins should be sized to store accumulated sediment.
- Measures to address overflows are required.
- Detention basin outlet should be designed to meter out post-development low flow discharge at a rate similar to pre-development conditions.
- Pilot channel may be of turf (for low velocity flows) or permanent turf mat (for higher velocity flows).

#### References:

Public Improvement Standard Section 5.2.2 "Basins"

See California Stormwater BMP Handbook Infiltration Basin and Extended Detention Basin Treatment Control Fact Sheets at Detention basins:

http://www.cabmphandbooks.com/Documents/Municipal/TC-22.pdf http://www.cabmphandbooks.com/Documents/Development/TC-11.pdf

### 4.3.4 Curb and Gutter Alternatives

Credit B.3 1-3 Credits

## <u>Description</u>

Curb, gutters and catch basin inlet systems are highly discouraged for use as stormwater collection systems because they concentrate flows and pollutants, increase velocities and discourage groundwater recharge.

#### Applicability

Alternatives to curb and gutter are encouraged in parking lots and in low- and medium-density residential zones where soils and slopes permit.



#### Limitations

Drainage inlets may be more appropriate in localized areas subject to frequent flooding during minor rain events. Curb and gutter systems may be required in urban settings, or where a new road must tie into an existing collector road. Additionally, where high-speed traffic and pedestrian use occur in the same vicinity, a curbs and gutter system may be necessary to provide distinct area for each use.

### Design Criteria

- Where curb and gutters have been designated as a means of separation between pedestrians and motorized traffic, consider the following hybrid LID/conventional stormwater management approaches:
  - The ability to place a vegetated channel between the sidewalk and the roadway.
  - The potential to incorporate a two-foot side concrete strip constructed along the edge of the pavement at the same surface elevation of the pavement. This concrete strip gives drivers a visual cue of the edge of the driving surface and helps protect the vegetated channel from tire ruts.
  - Implementing a curb and gutter system on one side of the road and allowing the road to drain to the other side of the road (road will have super-elevation instead of crowned section).
- Where curb and gutter systems are required for drainage purposes, curb cuts can be spaced strategically to allow runoff to enter adjacent channels. Curb cuts initially discharge into a surface feature (such as a planter or sand filter) where there is an opportunity to infiltrate runoff instead of conveying it directly to a subsurface drainage network. The frequency of curb cut openings is determined to minimize the spread width of stormwater on the road during primary storm events or to keep the volume and velocity of discharge passing through the curb cut from being erosive in the vegetated swale.
- Parking lots that incorporate sumped vegetation areas can use wheel stops in lieu of curb systems to protect the vegetated area from traffic intrusion while allowing parking lot runoff to be drained into the vegetation.
- The design shall provide an emergency overflow path.

#### References:

For more information on Curb-cuts, see San Diego Co. LID Handbook Fact Sheet 17: http://www.co.san-diego.ca.us/dplu/docs/LID-Handbook.pdf Lower Columbia River Field Guide to Water Quality Friendly Development: <a href="http://www.lcrep.org/fieldguide/examples/curbalternatives.htm">http://www.lcrep.org/fieldguide/examples/curbalternatives.htm</a> Idaho Department of Environmental Quality Best Management Practices Catalog: <a href="http://www.deq.state.id.us/water/data">http://www.deq.state.id.us/water/data</a> reports/storm water/catalog/sec 3/bmps/34.pdf

# 4.3.5 Alternative Parking Surfaces

## Description

Impervious surfaces increase the amount of surface runoff and contribute to heat island effects and pollutant loading as stormwater runs over the impervious surface.

Permeable pavement surfaces may be used to replace traditionally impervious surfaces. Examples of materials that have increased permeability include:

- Unit pavers
- Granular materials
- Poured-in-place materials
- Porous concrete or asphalt

Credit B.2.2 1 Credit



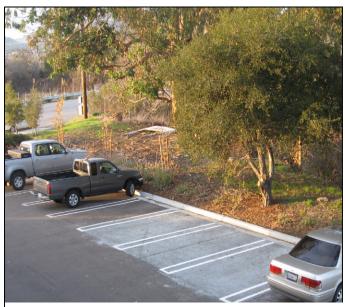
Porous concrete and asphalt are similar to traditional concrete and asphalt except that these products are made without the fines.

#### **Applicability**

These procedures are suitable for parking lots and driveways with generally flat surfaces. Alternative parking surfaces are most effective in areas with native sandy soils.

#### Limitations

The designer must certify that any porous surface proposed for use is able to provide adequate structural integrity for the intended purpose. These materials are not suitable for areas with a hard pan soils, high water table or in commercial/industrial areas of any soil type that have the potential for hazardous spills to occur on the parking surface. Development projects in areas with native clay soils require a subsurface drainage system.



Source Wallace Group. Porous concrete was used in lieu of traditional asphalt to protect the oak tree adjacent to the parking lot.

Paving surfaces must accommodate pedestrian (including ADA requirements), bicycle and auto traffic while allowing infiltration and storage of stormwater.

# Design Criteria

- Replace traditional impervious parking surfaces with an alternative pervious surface such as porous concrete, porous asphalt, permeable pavers, turf pave, etc. Pavers should have rigid edge systems to prevent movement of paving stones.
- Vegetate parking overhang areas or the area between the tire paths.
- Surface and stone recharge bed must be suitable for design traffic load.
- An underdrain is required for soils with limited infiltration rates.
- Terraced infiltration beds are required if porous concrete and asphalt are used on steep hills.
- Pre-treatment is advised in areas with high sediment loads.

The ability of porous concrete and asphalt to exchange air and water makes it especially suitable for use around trees.

#### References:

For more information on porous concrete, porous asphalt, permeable pavers, turf pave, please see: <a href="http://www.cabmphandbooks.com/Documents/Development/SD-20.pdf">http://www.cabmphandbooks.com/Documents/Development/SD-20.pdf</a>
<a href="http://www.redwoodcity.org/cds/angineering/pdf/DesignGuidelinesforPermeable-Pavemenths">http://www.redwoodcity.org/cds/angineering/pdf/DesignGuidelinesforPermeable-Pavemenths</a>

 $\underline{http://www.redwoodcity.org/cds/engineering/pdf/DesignGuidelinesforPermeablePavements.}\\ \underline{pdf}$ 

National Ready Mixed Concrete Association:

http://www.perviouspavement.org/

Georgia Stormwater
Management Handbook:
<a href="http://www.georgiastormwater.c">http://www.georgiastormwater.c</a>
om/vol2/3-3-7.pdf

# 4.3.6 Interceptor Trees

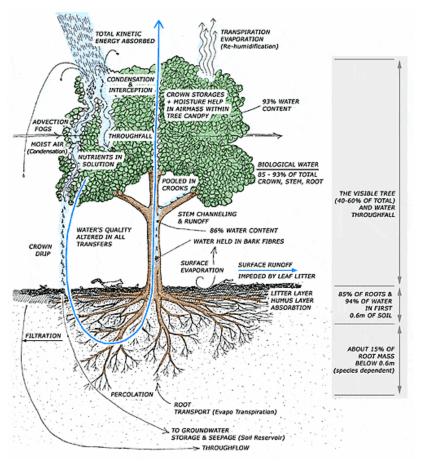
Credit D.4.1 / D.4.2 1-2 Credits

#### Description

Trees are effective in intercepting light storm events by temporarily capturing, storing and evaporating rain water from their leaves, branches and trunk bark.

#### **Applicability**

Interceptor trees are well suited for parking lots but can be



http://www.water-sos.org/sketches/trees-500pix.gif

incorporated into much of a project's landscaped areas.

#### Limitations

Trees should not be planted where they will interfere with utility lines (both surface and subsurface facilities) or create a fire hazard. Certain trees should not be used as their roots are known to damage adjacent impervious hardscapes. Consider the potential impacts of tree shade on adjacent structures and landscaping.

#### Design Criteria

Broadleaf evergreens and conifers intercept more rainfall than deciduous species. Trees that grow well in winter in San Luis Obispo County include:

- Cedrus deodara / Deodar Cedar
- Cupaniopsis anacardioides / Carrot Wood
- Ilex altaclarensis 'Wilsonii' / Wilson Holly
- Laurus nobilis 'Saratoga' / Sweet Bay
- Olea europaea / Olive (male specimens only)
- Pittosporum undulatum / Victorian Box
- Quercus ilex / Holly Oak
- Quercus suber / Cork Oak
- Quercus virginiana / Southern Live Oak
- Rhus lancea / African Sumac
- Tristania conferta / Brisbane Box
- Umbellularia californica / California Bay

Use native or drought tolerant plants to decrease the need for supplemental irrigation. Root barriers are suggested if trees will not be irrigated once established.

#### Resources:

US Forest Service Center for Urban Forest Research:

http://www.fs.fed.us/psw/programs/cufr/research/studies.php?TopicID=4

Trans-Agency Resources for Environmental and Economic Sustainability: <a href="http://www.treepeople.org/">http://www.treepeople.org/</a>

Rainfall interception and water loss from semiarid tree canopies: <a href="http://rangeland.tamu.edu/people/wilcox/RLEM%20689/7-transpiration%20interception/Owens%20et%20al.2006.pdf">http://rangeland.tamu.edu/people/wilcox/RLEM%20689/7-transpiration%20interception/Owens%20et%20al.2006.pdf</a>

Urban Forest Ecosystem Institute (tree information): <a href="http://selectree.calpoly.edu/name\_search.lasso">http://selectree.calpoly.edu/name\_search.lasso</a>

# 4.4 Building/Lot Level Design Considerations

The purpose of this section is to provide design guidelines appropriate for building or lot level considerations. Lot-level considerations are key to reducing the impacts associated with the "first flush." First flush describes the initial high pollutant load that occurs during the first (few) rainstorms of the season. The increased pollutant loading is a result of the rainfall-runoff process that mobilizes pollutants deposited on exposed areas that are dislodged and entrained in the initial runoff. First flush is most easily controlled at the individual lot level.

The following guidelines are intended to minimize stormwater impacts by incorporating stormwater friendly design principles into lot level or site specific project plans.

## **Guiding Principles**

- Reduce building footprint.
- Disconnect impervious surfaces.
- Amend soils.
- Use rainwater harvesting practices:
  - Disperse rooftops, impervious sidewalks, walkways, trails and patios into adjacent landscaping.
  - Incorporate bioretention facilities.
  - Incorporate rainfall reuse systems (i.e. rain barrels) at locations with unavoidable large contiguous impervious areas.
- Use level spreading of flow (sheet flow) into natural open space areas.
- Incorporate vegetated roofs.

# 4.4.1 Reduce Building Footprint/Foundation Excavation

Credit B.5 1 Credit

## **Description**

By minimizing the footprint and excavation associated with constructing a building, a greater area can be used to preserve some of the hydrologic functions for a site. Building footprints can be minimized by using pillars, pin foundations, multiple stories, and stepped foundations.

### **Applicability**

These procedures are suitable on all development projects but are most easily applied on large lots in rural areas.

#### Limitations

In areas with heavy clay soils, there is significant runoff from undeveloped areas and the addition of impervious areas may not significantly increase the amount of runoff. Building height restrictions may limit allowable structure heights which lead to increased structural footprints.

#### Design Criteria

To the extent possible, go up and not out and minimize construction area.

# References

Diamond Pier Pin Foundations

http://www.pinfoundations.com/green.htm

# 4.4.2 Disconnect Impervious Surfaces

Credit B.3.1 – B.3.3 1-3 Credits

#### Description

Impervious areas that drain into the stormwater system are considered "connected impervious areas." These areas can be "disconnected" by directing the runoff to a

landscaped area instead. Traditionally "connected" impervious areas well suited for "disconnection" include roof tops, parking lots and driveways.

# <u>Applicability</u>

These procedures are suitable on all development projects including redevelopment.

## Limitations

Runoff must be discharged at locations that will flow away from structures, have adequate area available to receive the runoff, and are sloped to avoid erosion.

## Design Criteria

To the extent possible,

- Roofing downspouts should be redirected to a yard, garden or swale or replaced with drip chains or scuppers.
- Runoff from driveways should not drain directly to a road; instead driveways should:
  - Be constructed from pervious materials, or
  - Be sloped to drain onto stabilized groundcover area, or
  - Be designed to intercept and drain runoff in dispersion trench to adjacent vegetated area.
- Sidewalks and street runoff should drain to stabilized groundcover areas.



Directing driveway runoff into a vegetated area by intercepting it with a trench drain is one way to reduce the volume of runoff leaving the site during small storms.



Above, NE Siskiyou green Street stormwater curb extension: Environmental services, City of Portland NEMO Nevada

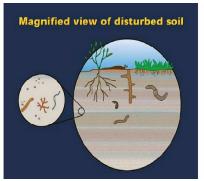


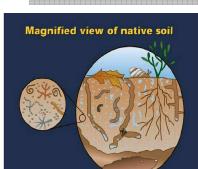
Above, roof scuppers are used to direct runoff through planters. This practice reduces the overall volume of runoff leaving the site during small storms. Source: www.tualatinriverkeepers.org

#### 4.4.3 Amend Soils

# **Description**

Physical, chemical and/or biological properties soils can be improved through the addition of soil amendments. The potential hydrologic benefits of compost soils include amended soil's increasing the permeability and water holding capacity, thereby





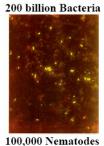
Credit A.2.1 / A.2.2 1-2 Credits

delaying and often reducing the peak stormwater runoff flow rate, and decreasing irrigation water, fertilizer and pesticide requirements.

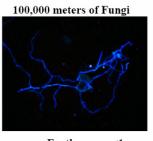
Disruption of soil can kill most of the beneficial biota and remove the air spaces in the soil that the aerobic biota need to thrive. Surface plantings, fertilizer and other nutrient supplements typically only help the first few inches of soil to develop new biota. Chemical fertilizer addition can actually kill or restrict the development of this biota. The biota is necessary for healthy vegetation.

A cup of undisturbed native topsoil can contain numerous bacteria. funai. protozoa, nematodes, earthworms and These arthropods. living organisms are essential for maintaining healthy soil.

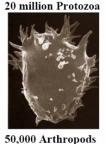
Where soil impacts cannot be avoided or sterile fill is brought in, the soil organic matter can be restored through













www.deq.state.or.us/lq/pubs/docs/sw/compost/RestoringSoilHealth.pdf

numerous materials such as compost, composted yard waste, industrial by-products and wood residuals. It is important that the materials used to improve post-construction soil quality be appropriate and beneficial to the plant cover to be established.

### Applicability

These procedures are suitable for soils that have been compacted as a result of construction or previous land use and for soils where the organic quality has been compromised due to overuse of pesticides and fertilizers or an exposure to household/industrial chemicals, concentration of pet waste or extreme and unnatural temperatures.

#### Limitations

Soil testing should be done to verify that soil amendments will produce a soil with similar chemistry, fertility and biology found in healthy regional soils.

#### Design Criteria

To the extent possible,

- Ripping, spading or tilling of the soil is recommended to alleviate soil compaction, wherever the subsoil has been compacted by equipment operation. Amending existing soil mitigates sub-soil compaction when compost is incorporated to a 12 inch depth.
- The upper eight inches of existing soils should be amended to restore the soil organic matter to pre-disturbed levels.

#### References:

Idaho Department of Environmental Quality Catalog of Stormwater BMPs:

http://www.deq.state.id.us/water/data\_reports/storm\_water/catalog/sec\_3/bmps/25.pdf http://www.deq.state.id.us/water/data\_reports/storm\_water/catalog/sec\_3/bmps/26.pdf City of Seattle Natural Yard Care public handout:

http://www.seattle.gov/util/Services/Yard/Natural Lawn & Garden Care/Natural Yard Care/index.asp

## 4.4.4 Harvest Rainwater

# Credit B.6.1 – B.6.3 1-3 Credits

# **Description**

Rainwater harvesting is the process of intercepting stormwater runoff from a surface and either letting it soak into the ground or storing it for reuse.

There are many types of rainwater harvesting practices including retention grading, rain gardens/bioretention cells, bioswales, pervious pavements, rain cisterns, rain barrels, and infiltration trenches.

# <u>Applicability</u>

Rainwater harvesting may be used as on-lot retention facilities in all types of planted soil. Rainwater harvesting is also appropriate in common areas.

#### Limitations

Infiltration practices must be situated away from structure foundations unless a barrier or waterproofing is incorporated into the building or pavement design. The bottom of the subgrade shall be at least 3 feet above the seasonal high groundwater level.

#### Design Criteria

While each type of rainwater harvesting practice has its unique design criteria, there are several design criteria that are common to all.

 Managing small volumes of water throughout the watershed is preferred over managing large volumes of stormwater at the bottom of the watershed. Begin at highest elevation of the site and continue to the lowest point of the site, dividing the site into small catchment areas. Flood control detention basin volume credit is

- allowed if the volume of runoff retained in smaller catchment areas can be quantified using a hydrograph analysis.
- Overland escape capable of handling large rainfall events up to the 100-year storm event is necessary.
- In facilities where standing water cannot be tolerated, an underdrain should be installed beneath the soil amendment layer.

#### Resources:

Brad Lancaster "Rainwater Harvesting for Drylands and Beyond": http://www.harvestingrainwater.com/

# 4.4.4a Retention Grading

Credit A.5.1 – A.5.3 1-3 Credits

#### Description

This practice involves the creation of shallow depressions on gently sloped or nearly flat landscapes. The shallow depressions intercept and infiltrate small volumes of surface water tributary to the depressed area.

## **Applicability**

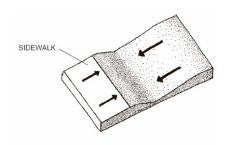
Retention grading works best in highly permeable soils.

## Limitations

Retention grading is not applicable for use on steep banks or in highly erodible soils. Ponded areas should be located 10 ft away from the structure foundation.

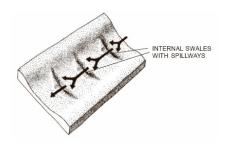
# Design Criteria

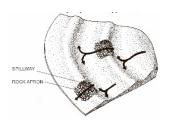
- 1. Vegetation is needed to stabilize soil and assist with infiltration and transpiration of runoff. Shrubs and trees should be planted slightly above the ponded water elevation. Grasses are generally used in the ponding area.
- 2. Catchment areas in new developments should be located and existing low points. In existing developments, grading may be necessary to create a low point.
- 3. Spillways or channels can be used to link and distribute water throughout the site.
- 4. Soils in catchment ponding areas should not be compacted.
- 5. For detailed design criteria associated with retention grading, go to Appendix F Part 1.

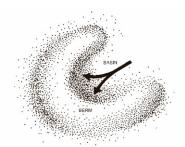












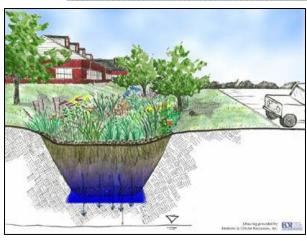
http://dot.tucsonaz.gov/stormwater/downloads/2006WaterHarvesting.pdf

# 4.4.4b Rain Gardens and Bioretention Cells

## Description

Rain gardens (also known as bioretention cells) are made from shallow depressions similar to retention grading. Native soil beneath the sump area is excavated out and backfilled with soil that serves to enhance retention and degradation of contaminants in stormwater runoff. The sump area is heavily planted and mulched. These low spots collect rain water during wet periods. Rain gardens reduce the volume of stormwater runoff delivered to surface water during the more frequent, low runoff events through plant interception and transpiration and by infiltration into the soil. The soil and root system also improves water quality.

Credit B.6.1 – B.6.3 (1-3 Credits) Credit C.13 (1 Credit)



http://ricecreek.org/bmp/rg

Rain gardens are differentiated from detention and retention basins based on their size.

#### Applicability

Rain gardens can be installed and are effective in most residential, commercial and industrial areas with NRCS type A and B hydrologic group soils. Projects located in NRCS type C and D hydrologic group soils require an underdrain. The NRCS soil web survey is available on-line<sup>2</sup>.

#### Limitations

Rain gardens are limited to a 5 acre or less tributary area and are not recommended on sites with steep slopes or with high ground water or bedrock elevations. Rain gardens should not be located over septic fields or leach lines, shallow utilities, or within 10 feet of a building foundation.

#### Design Criteria

- Rain gardens should be located downstream of impervious surfaces and a minimum of 10 feet from structure foundation
- Grass filter strips are excellent at pre-treating sediment laden runoff.

<sup>&</sup>lt;sup>2</sup> http://websoilsurvey.nrcs.usda.gov/

- Ponding depth is dependent on the underlying soils. The rain garden must drain within 72 hours. See Chapter 6 for information on determining infiltration rates.
- Rain garden must be equipped with an overland escape or overflow outlet.
- Rain garden vegetation should consist of diverse, native or drought tolerant species. Species at the bottom of the rain garden must be able to withstand wet conditions. Species planted on the side slopes must be able to withstand occasional inundation.
- Locations of rain gardens should be protected from construction site run-on and compaction.
- Backfill should be rich in aged organic matter with appropriate percolation rates.

#### Resources:

"Rain garden, Handbook for Western Washington Homeowners": <a href="http://www.pierce.wsu.edu/Water Quality/LID/Raingarden handbook.pdf">http://www.pierce.wsu.edu/Water Quality/LID/Raingarden handbook.pdf</a>

"Rain gardens, A How-to Handbook for Homeowners": http://clean-water.uwex.edu/pubs/pdf/home.rghandbook.pdf

#### 4.4.4c Bioswales

## Description

Bioswales function similarly to rain gardens except that they are sloped to a destination. They differ from vegetated swales, because in most instances, the bottom of the swale is replaced with soil that is more conducive to infiltration than existing site soils.

A subsurface stone recharge bed can be used to provide stormwater storage.



Credit B.3.1 - B.3.3 (1-3 Credits)

Credit D.1 (1 Credit)

Costco Bioswale. Source Wallace Group.

### Applicability

Bioswales can be installed and are effective in all residential and most commercial and industrial in all types of soil conditions.

## <u>Limitations</u>

Limited to a 5 acre or less tributary area. Bioswales are not recommended on sites with steep slopes or with high ground water or bedrock elevations. Bioswales should not be located over septic fields or leach lines, shallow utilities or within 10 feet of a building foundation. Bioswales should not be used in locations where there is a high sediment load or soils that are not stabilized.

### Design Criteria

Bioswales are most effective when used in conjunction with a filter strip or forebay.

- Bioswales should be located downstream of impervious surfaces and a minimum of 10 feet from structure foundation (unless structure foundation is protected by waterproof barrier).
- Swale bottom shall be sloped steep enough to drain but not so steep as to cause erosion. Bottom width should be a minimum of 2 feet wide (to uniformly spread stormwater at a slower velocity than a v-ditch would offer) and a maximum of 10 feet wide (to keep runoff from channelizing).
- Swale must be able to handle the storm events delivered to it without re-suspending sediments or scouring slopes.
- Locations of swales should be protected from polluted construction site run-on and compaction.
- Backfill should be rich in aged organic matter with infiltration rates that will allow the swale to drain within 72 hours.
- Swales should not convey stormwater at depths greater than 2 ft and should have gentle side slopes (5H:1V or flatter)
- When bioswales cross driveways (and intersecting roads and alleys), conveyance under the driveway can be provided by culverts or open graded rock veins wrapped in a getoextile.
- When bioswales are specified as a treatment control BMP, stormwater runoff should have a minimum 10 minute hydraulic residence time with a velocity less than 1 feet per second and the water surface elevation at the same height (or less) as the bioswale vegetation is required.

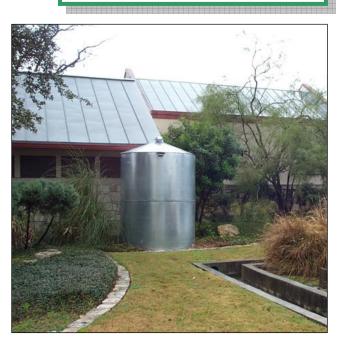
#### 4.4.4d Rain Cisterns and Rain Barrels

#### Description

Approximately 40 percent of all urban water use is for irrigation. Capturing and later reusing rainwater in water barrels or cisterns reduces the volume of runoff during rain events and conserves potable water supplies. Roof runoff contains no chlorine or hard minerals. It can easily be used later for landscape irrigation purposes or as collected water conveyed to typical grey water usages (flushing toilets).

In arid areas with heavy rainfall events, large cisterns are necessary if the goal is to capture entire rain events. For instance, a house in the City of San Luis Obispo subject to a 1 inch storm (0.083 ft), with a total roof area of 1000 square feet could yield 620.8 gallons of water for that storm event alone.

Credit B.6.1 – B6.3 (1-3 Credits)
Credit C.13 (1 Credit)



http://www.lid-stormwater.net/images/cistern4.jpg

Supply in Gallons = Roof Area directed to rain barrel x rain event, depth (ft) x 7.48 gallons/cf

= 1000 sf x 0.083 ft x 7.48 gallons/cf

= 620.8 gallons produced

That's enough water to meet the daily domestic needs of more than seven average Americans. Capturing the average annual runoff could yield over 12,000 gallons of water.

However to completely capture an entire 1 inch rain event, a total of twelve 55 gallon barrels would be needed (assuming that no draw was being taken from the barrel during the rain event and roof rain was lost to evaporation).

Number of 55 gallon barrels needed = 620.8 gallons / 55 gallons per barrel

= 11.3 barrels = 12 barrels

The equation below can be used to calculate the storm that would fill up a single 55 gallon barrel:

The depth of rain that will fill = Capacity of rain barrel (gallons)

Contributing roof area (sf) x 7.48 gallons/sf (conversion factor)

= <u>55 gallons</u> = 1000 sf/4 x 7.48 gallons/sf

= 0.03 inches of rain

Rain barrels can come in all shapes and sizes. For the committed rainwater harvester, a large underground tank (equipped with pumps) may be more suitable (but more costly) than an above ground tank.

#### **Applicability**

The volume of roof runoff to be intercepted is directly proportional to the area of the roof. A larger roof yields more runoff.

# Limitations

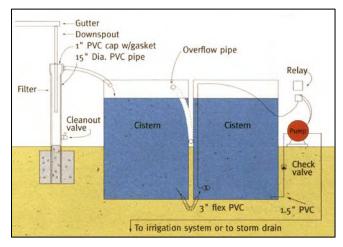
Roofs constructed with tar, gravel, treated cedar shakes or old asbestos shingle roofs may create too much contamination for rainwater harvesting. Similarly, rainwater should not be harvested if it is conveyed via gutters with lead soldering or lead-based paints. Runoff from roofs exposed to air borne particles originating from cement kilns, gravel quarries, crop dusting, or concentrated automobile emissions could adversely affect the rainwater quality.

Low storage capacities will limit rainwater harvesting so that the system may not be able to provide water in a low rainfall period. Increased storage capacities add to construction and operating costs.

### Design Criteria

- Sizing of cisterns and rain barrels should be based on roof area, rainfall patterns, anticipated water usage of connected plumbing facilities or landscape water needs.
- Rainwater collected and intended for flushing toilets will require a parallel plumbing system.

- Rainwater collected and intended for potable uses should include filtration and disinfection to eliminate potential contamination originating from leaves, bird droppings, dust, and other natural causes.
- Tanks should be securely covered with fine-mesh screens on all inlet and outlet pipes to keep mosquitoes from entering tanks. This also protects the tanks from inadvertently trapping and drowning children and wild or domestic animals.



TreePeople, Rainwater as a Resource: A Report on Three Sites Demonstrating Sustainable Stormwater Management, 2007.

- Rain cisterns and rain barrels Demonstratina Sustainable Stormwater Management. 2007.
   should be equipped with overflow devices able to convey spills away from any adjacent structures. Verify that the overflow device is adequately sized to convey the anticipated rain events it will be subject to.
- Consider installing a "first flush" diverter to increase stored water quality and reduce tank maintenance needs. The first flush diverter should allow the first 10 minutes of a storm event after a long dry period to bypass the system.

# References:

Rain Barrel Guide:

http://www.rainbarrelguide.com/

Aquabarrel Rain Barrel:

http://www.aguabarrel.com/

How to construct a Rain Barrel:

http://home.comcast.net/~leavesdance/rainbarrels/construction.html

#### 4.4.4e Infiltration Trenches

# Description

Infiltration trenches are shallow excavations that are lined with stone to create underground reservoirs. These trenches intercept runoff and store it until it can percolate into the soil through the bottoms and sides of the trench.

Infiltration trenches receiving polluted stormwater may introduce those contaminates into ground water supplies since they do not have the benefit of soil and roots to filter pollutants out.

Credit B.3.1 – B.3.3 1-3 Credits



Infiltration trench in Davis, CA

# **Applicability**

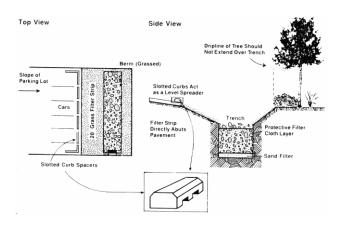
Infiltration trenches are recommended in areas with tributary areas less than 2 acres AND where pollutant loads are low and space is not available for bioretention BMPs.

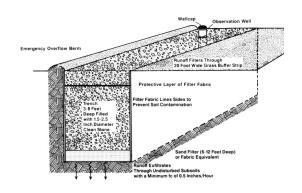
## Limitations

Not appropriate for soils without good drainage.

#### Design Criteria

- Soils percolation rate must allow the structure to drain within 72 hours.
- Stormwater directed towards infiltration trenches must be pretreated to remove suspended solids, nitrates and dissolved metals. Solids can clog the trenches. Nitrates and dissolved metals can be introduced into ground water supply.
- Equip with observation well.
- Infiltration trenches should be located to collect sheet flow from impervious surfaces.
- Infiltration trenches should have a flat bottom slope (or subsurface check dams if use in conjunction with sloped bioswale) and a narrow width to reduce mounding risks.





Souce: Schueler, 1987.

# References:

http://www.epa.gov/owmitnet/mtb/infltrenc.pdf

http://www.cabmphandbooks.com/Documents/Development/TC-10.pdf

# 4.4.5 Level Spreaders

Description Level spreaders Credit B.3.1 – B.3.3 1-3 Credits

disperse concentrated water over a wide enough area so that erosion of the receiving area does not result. It can reduce erosion and the movement of sediment. An additional benefit of a level spreader is to remove other pollutants from runoff by filtration, infiltration, absorption, decomposition and volatilization.



Level spreaders are constructed at zero grade across a slope and used to disperse or "spread" concentrated flow thinly over a source: NCSU-BAE receiving area.

# <u>Applicability</u>

- Where runoff from an impervious surface is uneven and/or runoff is released as concentrated flow, such as through curb cuts or roof downspouts.
- At the ends of diversions.
- Where the lip of the level spreader can be constructed in undisturbed soil.
- Where there will be no traffic over the spreader.

#### Limitations

Level spreaders address concentrated flows in small tributary areas (less than 2 acres) and should not be used on steep slopes or highly erodible gentle slopes.

## Design Criteria

The spreader lip shall be constructed to a uniform height and zero grade over the length of the spreader. The length of the level spreader lip is based on the volume of water that must be discharged. In general,

- The weir can be constructed of gravel, timber, asphalt, or concrete or of vegetation.
   Vegetated weirs work best in areas with low flows. However if vegetation is used, it must be inspected frequently to ensure that the vegetated weir will function properly over the range of flows it is subject to.
- Flow volumes and velocities should be verified to ensure that they do not cause channelized flow and erosion in receiving areas.

# References:

http://www.lrc.usace.army.mil/co-r/level%20spreader.pdf http://h2o.enr.state.nc.us/ncwetlands/documents/LevelSpreaderGuidancefinal.pdf

# 4.4.6 Vegetated "Green" Roofs

Description
Standard
roof tops

accelerate

Credit C.10 1 Credit

and increase stormwater runoff. Replacing the traditional impervious roof with a vegetated roof can make substantial improvements in stormwater runoff quality and quantity.

There are two types of vegetated roofs: eco-roofs and roof gardens. Eco-roofs are lightweight roof systems supporting a few



Vegetated Rooftop over car wash facility in San Luis Obispo

inches of soil and small plants while roof gardens are heavy roofs, usually with a foot or more of soil supporting large plants, shrubs, or trees, either directly on the roof or in planters.

Both types of vegetated roofs slow runoff and increase interception, evaporation, and transpiration of stormwater, in addition to reducing heat island effects associated with roofs. Vegetated roof systems can extend the life of the roof by 2-3 times over conventional roofing systems while reducing the energy required for heating and cooling of the structure.

#### Applicability

Vegetated roofs are best suited on new construction projects with flat roofs (pitches less than 1.5 percent) and no opportunities to infiltrate or store roof water in other locations on the site.

#### Limitations

In retrofit applications, load restrictions are usually the main limitation. Follow state and/or local standards with respect to wind and fire resistance of rooftop elements. Extreme sun or wind conditions present a challenge for plant survival. Vegetated roofs may not be appropriate for areas with snow or rooftops with slopes greater than 15 percent and may require irrigation.

#### Design Criteria

To the extent possible, impervious surface should be replaced with more pervious surfaces. Vegetated roofs are one way to reduce the impact of the project's overall impervious area; however, infiltration techniques are favored over green roofs in areas with groundwater recharge priorities.

Vegetated roofs should be planted with drought tolerant species, but may require supplemental water.

#### References:

Green Roofs for Healthy Cities: http://www.greenroofs.org



Photo, exterior overview of roofs and distant context · Gap Offices in San Bruno, CA http://www.greatbuildings.com/buildings/Gap Offices in San Bruno.html

# Ch 5: Preventing Stormwater Pollution at the Source – Source Control Measures

#### 5.1 Introduction to Source Control

Source control refers to any schedules of activities, prohibitions of practices, maintenance procedures, managerial practices or operational practices that prevent stormwater pollution by reducing the potential for contamination at the source of pollution.

Source control measures are required for all projects. Source control measures can be categorized as Structural, Procedural or Operational.

<u>Structural</u> source control measures are physical measures employed to prevent stormwater from contacting work and storage areas to prevent stormwater from picking up pollutants.

<u>Operational</u> source control BMPs are non-structural practices such as employee training, record keeping, good housekeeping, preventative maintenance, spill prevention and cleanup.

<u>Procedural</u> source controls BMPs include implementing process changes such as substituting a less hazardous material for a highly hazardous material in an industrial process.

Implementing operational and procedural source control BMPs are generally considered more cost-effective in minimizing pollution than structural source control measures. Operational and procedural source controls are addressed in Chapter 8 "Operation and Maintenance" of this handbook.

While some source control measures can be broadly applied to development, others are site and pollutant specific. This chapter describes the purpose, design criteria, maintenance requirements and appropriate use of structural source control measures approved for use in the unincorporated areas of San Luis Obispo County.

### **5.2 General Structural Source Control Measures**

The source control measures included in this section generally apply to all development.

#### 5.2.1 Storm Drain Markers

# <u>Description</u>

Storm drain markers are highly visible source controls that are placed adjacent to storm drain inlets. This measure informs the public that runoff drains

Prerequisite C.1
PRIORITY: Required
STANDARD: Required



directly to water bodies. Storm drain markers raise awareness to help deter littering and illegal dumping.

# <u>Applicability</u>

Storm drain marking procedures are suitable for storm drain inlets with concrete curb and gutters.

## Design Criteria

• All new storm drain inlets shall be provided with a marker as specified by the County Public Improvement Standards.

## References:

See CASQA SD-13 for additional design, installation and maintenance considerations: <a href="http://www.cabmphandbooks.com/Documents/Development/SD-13.pdf">http://www.cabmphandbooks.com/Documents/Development/SD-13.pdf</a>

# 5.2.2 Alternative Building Materials

Credit C.10 1 Credit

## **Description**

Some building materials, such as copper, are prone to leach toxic compounds into stormwater runoff. Some building materials require the routine use of pollutants (i.e. toxic paints and finishes) to maintain their integrity. This BMP employs alternative materials that are not prone to leach toxic compounds or require toxic compounds to maintain their integrity.

#### **Applicability**

Alternative building materials are suitable for all developments.

#### Design Criteria

- Consider using building materials that incorporate green technology, use less toxic materials in their manufacturer, or require minimum maintenance.
- Avoid roofing, gutters, and trim made of copper or other unprotected metals that could leach into runoff.

## References:

See CASQA SD-21 for additional design, installation and maintenance considerations: <a href="http://www.cabmphandbooks.com/Documents/Development/SD-21.pdf">http://www.cabmphandbooks.com/Documents/Development/SD-21.pdf</a>

# 5.2.3 Clean Water Segregation

Credit C.13 1 Credit

#### Description

Runoff originating from roof and landscaped areas is considered relatively clean. Runoff increases its risk of picking up contaminants if it is allowed to flow over parking lot areas.





Roof top runoff inappropriately discharged onto pavement (left) will pick up parking lot pollutants. Roof top runoff discharged into stabilized landscaped areas or rain water cisterns is available for infiltration or onsite reuse.

Adding relatively clean runoff into the treatment train or stormwater treatment process can reduce the overall effectiveness of the treatment train in removing contaminants.

## **Applicability**

Clean water segregation is suitable for all properties with roof drains and/or vegetated areas that produce runoff.

#### Limitations

Clean water segregation is not appropriate for roof runoff from industrial areas or from runoff traveling over galvanized metal roofs, roofs fabricated with electroplating and metal finishes, including the use of copper chloride etchers, ammonia etchers or that have acid plant bath exhaust vents. Runoff from galvanized roofs should be treated prior to discharge from the site.

### Design Criteria

- Relatively clean runoff should be kept isolated from runoff requiring treatment. This can be achieved by:
  - Retaining runoff on site.
  - Directing roof runoff into vegetated areas.
  - Connecting roof and landscape area runoff into a separate storm drain system.
  - Connecting roof and landscape runoff into the site's storm drain system after treatment BMPs to ensure parking lot pollutants have been addressed.
  - Detaining roof and landscape runoff onsite long enough for first flush parking lot runoff to be treated and then sending it from the site in a common storm drain system.
- Consider reuse of roof rain water.

#### References:

See Fact Sheet SD-11, "Roof Runoff Controls," in the CASQA Stormwater Quality Handbooks at: http://www.cabmphandbooks.com/Documents/Development/SD-11.pdf

# 5.2.4 Efficient Irrigation

Credit C.11 1 Credit

#### Description

Efficient irrigation techniques minimize waste and reduce the amount of dry weather runoff discharged to the storm drain system. Efficient irrigation techniques include rain and wind-triggered shutoff devices, automatic line break detection shutoff valves and soil moisture sensors.

## Applicability

Efficient irrigation is suitable for all development with irrigated areas.

## <u>Limitations</u>

None

### Design Criteria

To the extent possible, install

- Native plants that require minimum irrigation.
- Irrigation controllers with evapotranspiration, high wind, and rainfall sensors to
  prevent over- and under-watering and watering during rainfall events and/or with
  programmable schedules to set watering time and duration according to plant and
  seasonal needs.
- "Smart" irrigation controller with master valve connected to flow sensor to detect and shut off water when the sensor indicates an out of expectation flow rate.

# References:

A list of "smart" controllers is available at:

http://www.irrigation.org/SWAT/Industry/ia-tested.asp.

See CASQA SD-12 for additional design, installation and maintenance considerations: http://www.cabmphandbooks.com/Documents/Development/SD-12.pdf

# 5.3 Site and Pollutant-Specific Structural Source Control Measures

The source control measures included in this section apply to specific types of development or are specified to control specific types of pollutants.

# 5.3.1 Fueling Areas

# Required – Priority Credit C.3 1 Credit (Standard)

#### Description

Fueling areas have the potential to contribute oils, grease, solvents, car battery acids, coolants and fuels to stormwater conveyance systems. Spills at vehicle and equipment fueling areas can have a significant impact on the quality of stormwater runoff because fuels contain heavy metals and toxic substances that are not easily removed by stormwater treatment devices. Spill prevention is paramount.

# **Applicability**

The design criteria below (items 1-4) are mandatory for projects with

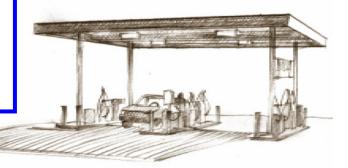


fueling dispensing equipment.

#### Design Criteria

- The fuel dispensing area must be covered with an overhanging roof structure or canopy. The canopy's minimum dimensions must be equal to or greater than the area within the grade break. The canopy must not drain onto the fuel dispensing area, and the canopy downspouts must be routed to prevent drainage across the fueling area.
- The fuel dispensing area must be paved with Portland Cement Concrete (or equivalent smooth impervious surface). The use of asphalt concrete is prohibited.
- The fuel dispensing area must have a 2% to 4% slope to prevent ponding, and must be separated from the rest of the site by a grade break that prevents run-on of stormwater to the extent practicable.
- At a minimum, the concrete fuel dispensing area must extend 6.5 feet from the corner of each fuel dispenser, or the length at which the hose and nozzle assembly may be operated plus 1 foot whichever is less.
- Signs discouraging the topping-off of fuel tanks should be posted.
- Spill response kits, including absorbent materials and disposal containers for accidental spills should be clearly located within the fueling area.

The best fuel island design has a cover for all the dispensers and prevents any stormwater from running over and removing contaminates from the fueling area. Keep spill kits at fuel islands, if possible.



#### References:

See CASQA SD-30 for additional fueling area design, installation and maintenance considerations: http://www.cabmphandbooks.com/Documents/Development/SD-30.pdf

# **5.3.2 Maintenance Bays and Loading Docks**

#### Description

Oil and grease, solvents, car battery acid, coolant and gasoline from repair/maintenance bays can negatively impact water quality if allowed to come in contact with stormwater runoff.

Required – Priority Credit C.4 / C.5 1-2 Credits (Standard)

#### Applicability

These procedures are suitable for all commercial and industrial applicable locations.

#### Design Criteria

• Repair/maintenance bays must be indoors or designed in such a way that does not allow contact with stormwater run-on or runoff.

- Design a repair/maintenance bay drainage system to capture all wash water, leaks and spills. Connect drains to a sump for collection and disposal. Direct connection of the repair/maintenance bays to the storm drain system is prohibited. If required, obtain an Industrial Waste Discharge Permit and ensure that drains are equipped with a fail-safe valve that remains closed except during rainfall.
- Cover loading dock areas or design drainage to minimize run-on and runoff of stormwater. If roof is used to shelter locking maintenance bay and loading docks from stormwater, the roof should be surfaced with a non-metallic material to decrease the likelihood of introducing heavy metals into the stormwater system.
- Loading dock area drains connected to the storm drain system must be equipped with a valve or equivalent device that remains closed except during rainfall.
- Loading docks for loading and unloading liquids in containers shall be provided with an inlet with a shutoff value and have the capacity to hold a spill while the value is closed.
- Door skirts between the trailers and the building should be installed to prevent exposure of loading activities to rain.

#### References:

See CASQA SD-31 for maintenance bay and loading dock design, installation and maintenance considerations:

http://www.cabmphandbooks.com/Documents/Development/SD-31.pdf

# **5.3.3 Trash/Recycling Storage Areas**

## Description

The trash and recycling storage area refers to an area where a trash receptacle or recycling receptacles (dumpsters) are located for use as a repository for solid wastes. Loose trash and debris can easily be transported by the forces of water or wind into nearby storm drain inlets, channel, and/or creeks.

# Applicability

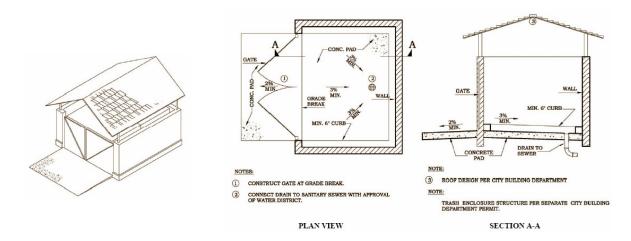
These procedures are suitable for all multi-family residential units with four or more units, commercial projects, and industrial trash areas. Single family residences are exempt from these requirements.

#### Design Criteria

- Project design should provide an appropriate number of adequately sized receptacles.
- Trash and recycling storage areas must divert drainage from adjoining roofs and pavements around the area(s). Project plans should show how the container area will be graded and paved to prevent run-on to the area and to prevent runoff from leaving the area.
- Trash and recycling storage container areas must be screened or walled to prevent offsite transport of trash.
- Trash and recycling storage within containers should be secured to prevent loose trash and debris from being dispersed by the wind.
- Uncovered bins should be roofed to prevent rainwater from co-mingling with bin contents.

Required – Priority
Credit C.6
1 Credit (Standard)

- Trash and recycling storage enclosure pads should be designed to drain to a
  pervious surface through indirect soil infiltration or to an appropriate treatment control
  BMP prior to connection to a sanitary sewer.
- The proposed enclosure detail shall be submitted to the County and contracted recycling and garbage hauler for review and approval. Before a building permit can be issued, a form from each hauler accepting the relevant container location and enclosure detail must be submitted.
- No connection to the storm drain system is allowed for new facilities.



# References:

See CASQA SD-32 for additional trash storage area design, installation and maintenance considerations:

http://www.cabmphandbooks.com/Documents/Development/SD-32.pdf

# 5.3.4 Vehicle and Equipment Wash Areas

#### Description

Vehicle and equipment wash waters commonly contain high concentrations of sediments, oils and grease, cleaning

Required – Priority
Credit C.7
1 Credit (Standard)

chemicals, phosphates, antifreeze and heavy metals. These materials are prohibited from entering the storm drain system through the illicit discharge detection elimination ordinance.

### **Applicability**

These procedures are suitable for all multi-family residential, commercial and industrial areas.

## Design Criteria

Describe measures taken to discourage onsite vehicle and equipment washing and explain how these will comply with the appropriate design criteria provided below for commercial/industrial, restaurant, and residential applications.

#### Commercial/industrial applications:

 Commercial/industrial facilities having vehicle/equipment cleaning needs shall either provide a covered, bermed area for washing activities or discourage

- vehicle/equipment washing by removing hose bibs and installing signs prohibiting such uses.
- Commercial car wash facilities shall be designed such that no runoff from the facility is discharged to the storm drain system.
- Wastewater from the commercial vehicle and equipment wash areas shall be equipped with a clarifier, or other pretreatment facility, and properly connected to the sanitary sewer, or other appropriately permitted disposal facility.
- Secondary containment shall be provided for exterior work areas where motor oil, brake fluid, gasoline, diesel fuel, radiator fluid, acid-containing batteries or other hazardous materials or hazardous wastes are used or stored. Drains shall not be installed within the secondary containment area.
- Vehicle wash water should only be discharged to the sanitary sewer and only after obtaining permission from the local wastewater treatment authority. Fueling and maintenance activities shall be isolated from vehicle and equipment wash areas.
- Tanks, containers or sinks used for parts cleaning or rinsing shall not be connected to the storm drain system and may only be connected to the sanitary sewer system. These connections may require additional approvals and permits.

# Residential application:

- Multi-dwelling complexes shall have a paved, bermed, and covered car wash area (unless car washing is prohibited onsite and hoses are provided with an automatic shutoff to discourage such use).
- Washing areas for cars, vehicles, and equipment shall be paved, designed to prevent run-on to or runoff from the area and in large common areas plumbed to drain to the sanitary sewer.

# Restaurant application:

- Restaurant wash areas must be self-contained and equipped with a grease trap and properly connected to a sanitary sewer.
- Food service facilities, including restaurants and grocery stores shall have a sink or other area for cleaning floor mats, containers and equipment. The cleaning area must be located over a paved area and have secondary containment. It must be large enough to clean the largest mat or piece of equipment that needs cleaning. The sink or cleaning area shall be connected to a grease interceptor prior to discharge to the sanitary sewer system.

## References:

See CASQA SC-21 for additional vehicle washing area design, installation and maintenance considerations:

http://www.cabmphandbooks.com/Documents/Industrial/SC-21.pdf

# **5.3.5 Material Storage Areas**

#### <u>Description</u>

Outdoor material storage areas include areas or facilities designated solely for storage of materials. Improper storage of

Required – Priority
Credit C.8
1 Credit (Standard)

materials outdoors may provide an opportunity for toxic compounds, oil and grease, heavy metals, nutrients, suspended solids, and other pollutants to enter the storm drain system.

Proper storage is necessary to prevent materials being stored outside from being washed away in stormwater runoff, spilled, or inadvertently discharged to the storm drain system.

#### Applicability

These procedures are suitable for all projects that include outdoor storage areas for materials. Sites with large quantities or liquids or bulk materials at sites that are connected to the storm drain system are at greatest risk, including:

- Nurseries and garden centers
- Auto recyclers/body shops
- Building supply outlets
- Landfills and recycling centers
- · Solid waste and composting facilities
- Maintenance depots
- Power plants



- Store materials indoors, if feasible.
- Infiltration is discouraged in outdoor material storage areas.
- Protect materials stored outside from rainfall and wind dispersal by keeping them in an enclosure such as a cabinet or shed.
- Protect materials stored outside from run-on by constructing a secondary containment structures (such as berms, dikes or curbs) around the perimeter of the storage area.
- Provide an area to pool spills for collection and disposal or, if allowed, pre-treat and drain the area to the sanitary sewer system. If required, obtain an Industrial Waste Discharge Permit. Secondary containment areas should be sized to hold 110% of the volume of the storage tank or container unless other containment sizing regulations apply (e.g. fire codes).
- Store materials on paved or impervious surfaces.
- Exterior storage areas shall be covered with a roof or awning to minimize collection of stormwater within the secondary containment area.

#### References:

See CASQA SC-33 for additional outdoor material storage area design, installation and maintenance considerations:

http://www.cabmphandbooks.com/Documents/Industrial/SC-33.pdf

# 5.3.6 Pools, Spas and Fountains

Credit C.9 1 Credit

#### Description

Draining pools, spas and fountains to the street, gutter or storm drain system can pollute water bodies with copper, chlorine, sediments and other contaminates.

#### Applicability

These procedures are suitable for all properties with a pool, spa and/or fountain.



### Design Criteria

- The preferred method to discharge decholorinated/debrominated pool, spa and/or foundation algae-free water with pH levels between 6.5 and 8.5 is onto adjacent land surfaces.
- Pool, spa and/or fountain discharges not able to be drained onto adjacent land surfaces should be drained to a sanitary sewer cleanout—never to a street, gutter, or storm drain system.

Water from pools, spas and fountains should only be discharged to the sanitary sewer only after obtaining permission from the local wastewater treatment authority. See CASQA SC-72 or other the other link for "Fountain and Pool Maintenance" considerations:

http://phoenix.gov/WATER/pooldrn.html

http://www.cabmphandbooks.com/Documents/Municipal/SC-72.pdf

# 5.3.7 Outdoor Work and Processing Areas

#### Description

Outdoor work areas, such as material collection or cleaning points, and outdoor processing areas, such as painting, grinding degreasing areas, have the potential to contribute metals, oil and grease, solvents, phosphates, and suspended solids to the storm drain system.

#### Applicability

These procedures are suitable for all properties with outdoor work and/or processing area.

### Design Criteria

- Infiltration is discouraged.
- Keep runoff from relatively clean areas separate from relatively dirty areas by installing diversion drains or berms.
- When practical, provide a roof over the work area.
- Equipment and accessory washing/steam cleaning facilities should be self-contained and equipped with a grease trap that discharges to the sanitary sewer system.

#### References:

See CASQA SD-35 and SD-36 for additional Outdoor Work Area and Outdoor Processing Area considerations:

http://www.cabmphandbooks.com/Documents/Development/SD-35.pdf http://www.cabmphandbooks.com/Documents/Development/SD-36.pdf

# 5.3.8 Pet Mitt Stations

Credit C.14
1 Credit

#### <u>Description</u>

Pet waste is a known contributor to stormwater pollution. Providing pet mitt stations at locations that are attractive to dog owners can encourage owners to pick up pet waste.

#### **Applicability**

These procedures are suitable for all properties with large, accessible open areas.

<u>Design Criteria</u>
Pet mitt stations should consist of a dispenser with biodegradable bags for scooping the poop, informational signage and a trash cans should be provided for convenient disposal.

References County Parks Mutt Mitt Program

# **Ch 6: Hydromodification Control Measures**

Hydromodification control BMPs are not currently required. Hydromodification control requirements are in the process of being developed as part of the Joint Effort, which is a collaborative process being undertaken by several municipalities throughout the Central Coast Region. This is a two-year process which was initiated in October 2009.

Upon completion of the Joint Effort, hydromodification control requirements developed through that process will be adopted into Chapter 6 of this document. Adoption will occur by resolution of the Board of Supervisors after a duly noticed public hearing. Once adopted, projects will need to comply with the hydromodification control requirements.

More information on the Joint Effort can be obtained from the Regional Water Quality Control Board's website<sup>1</sup>.

<sup>1</sup> 

# **Ch 7: Treatment Control Measures**

### 7.1 Introduction to Treatment Control

Stormwater leaving a site must meet the treatment goals established in Chapter 2.

The following outlines the preference for treatment control implementation:

- Prevent and eliminate the need for treatment control.
  - See source controls.
  - Increase public awareness and employee training.
- Use LID practices to eliminate runoff from storms.
- Use LID practices to capture pollutants from stormwater streams. Treatment control BMPs should be placed as close to the source of pollutant as possible.
- Use conventional "end of pipe" treatments as the last option.

Chapter 5 provides information on source controls appropriate for varying types of development. Chapter 6 (when completed) will provide information on ways to reduce the volume of runoff leaving the site. This chapter describes treatment controls including LID practices that can be used to capture pollutants from runoff as well as conventional "end of pipe" treatments. This chapter also contains ancillary devices that can be incorporated into designs to provide enhanced treatment. Projects discharging to Clean Water Act 303(d) listed water bodies must address all constituents that will contribute to the impairment of the water body. Structural treatment control stormwater BMPs should be implemented close to pollutant sources to maximize pollutant removal. Such BMPs may be located onsite or offsite, used singly or in combination, or shared by multiple new developments.

#### 7.2 Treatment Control BMPs

Each project has unique features that make it particularly well suited for a specific BMP or which can eliminate specific BMPs from consideration. Characteristics that may influence the selection of a treatment control BMP include tributary area to the BMP, land use, site slopes, soils, cost, etc. This section discusses some of the physical constraints that might influence the selection of a treatment control BMP. To create a list of viable treatment controls for a particular site, begin the initial review with the list of acceptable treatment control BMPs below.

Infiltration Trench (TC-10)

Retention Basin (TC-11)

Vegetated Swale (TC-30)

Bioretention (TC-32)

Media Filters (TC-40)

Catch Basin Inserts

Constructed Wetland (TC-21)

Detention Basins (TC-22)

Vegetated Filter Strip (TC-31)

Surface Sand Filters

Oil & Water Separators (TC-50)

Proprietary Systems

Treatment control BMPs are not meant to be isolated components, rather they should be part of an integrated stormwater management treatment train.

#### **Infiltration Trenches (TC-10)**

An infiltration trench is an excavated trench, backfilled with a stone aggregate, and lined with filter fabric. Pollutants are filtered out of the runoff as it infiltrates the surrounding soils. Infiltration trenches are highly effective at removing sediment, nutrients, trash, metals, bacteria, oil and grease, organics and oxygen demanding constituents.

For additional information regarding infiltration trenches. <a href="http://www.cabmphandbooks.com/Documents/Municipal/TC-10.pdf">http://www.cabmphandbooks.com/Documents/Municipal/TC-10.pdf</a> or <a href="http://www.epa.gov/owmitnet/mtb/infiltrenc.pdf">http://www.epa.gov/owmitnet/mtb/infiltrenc.pdf</a>

#### **Constructed Wetlands (TC-21)**

Constructed wetlands are excavated basins with an undulating bottom into which wetland vegetation is purposely placed to enhance pollutant removal from stormwater runoff. Constructed wetland remove solids and course organic material, soluble nutrients and some dissolved nutrients.

For additional information regarding constructed wetlands. http://www.cabmphandbooks.com/Documents/Municipal/TC-21.pdf

# **Retention Basins (TC-11)**

Infiltration facilities store runoff until it gradually infiltrates into the soil. Retention basins are highly effective at removing sediment, nutrients, trash, metals, bacteria, oil and grease, organics and oxygen demanding constituents.

For additional information regarding retention basins. <a href="http://www.cabmphandbooks.com/Documents/Municipal/TC-11.pdf">http://www.cabmphandbooks.com/Documents/Municipal/TC-11.pdf</a>

#### **Detention Basins (TC-22)**

Detention basins are basins where outlets have been designed to detain stormwater runoff from a storm for some minimum time (e.g., 72 hours) to allow particles and associated pollutants to settle out. Detention basis are less effective than retention basins at removing sediment, metals, bacteria, oil and grease, organics and oxygen demanding constituents. The efficiency removal rate corresponds to detention time, with higher removal efficiency rates with longer detention times.

For additional information regarding detention basins. http://www.cabmphandbooks.com/Documents/Municipal/TC-22.pdf

# **Vegetated Swales (TC-30)**

Vegetated swales are shallow channels with vegetation covering the side slopes and bottom that collect and slowly convey runoff flow to downstream discharge points. They are designed to treat runoff through filtering by the vegetation in the channel, filtering through a subsoil matrix, and/or infiltration into the underlying soils. Swales are moderately effective at trapping particulate pollutants (suspended solids and trace metals). Swales can contribute to increased nutrient loads if over-fertilized.

For additional information regarding vegetated swales. <a href="http://www.cabmphandbooks.com/Documents/Municipal/TC-30.pdf">http://www.cabmphandbooks.com/Documents/Municipal/TC-30.pdf</a>

### **Vegetated Filter Strip (TC-31)**

Vegetated filter strips are vegetated surfaces that are designed to treat sheet flow from adjacent surfaces. Filter strips function by slowing runoff velocities and allowing sediment and other pollutants to settle out. They are highly effective at removing sediment, metals and oil and grease. They are not very efficient at removing nutrients and bacteria.

For additional information regarding vegetated filter strips. http://www.cabmphandbooks.com/Documents/Municipal/TC-31.pdf

#### **Bioretention (TC-32)**

Bioretention facilities remove pollutants through a variety of physical, biological, and chemical treatment processes that are soil and plant-based. Bioretention facilities are highly effective at removing sediment, trash, metals, bacteria, oil and grease, organics and oxygen demanding constituents. Nutrients can be effectively removed by properly maintained bioretention facilities; however, over fertilized bioretention facilities can introduce nutrients into the system.

For additional information regarding bioretention facilities. <a href="http://www.cabmphandbooks.com/Documents/Municipal/TC-32.pdf">http://www.cabmphandbooks.com/Documents/Municipal/TC-32.pdf</a>

#### **Surface Sand Filters**

Sand filter systems consist of two or three chambers or basins. The first is the sedimentation chamber, which removes floatables and heavy sediments. The second is the filtration chamber which removes additional pollutants by filtering the runoff through a sand bed. The third is the discharge chamber. Sand filters are able to achieve high removal efficiencies for sediment, biochemical oxygen demand (BOD), and fecal coliform bacteria; however, removal efficiencies for metal, is moderate, and nutrient removal is often low.

For additional information regarding surface sand filters. <a href="http://www.epa.gov/owmitnet/mtb/sandfltr.pdf">http://www.epa.gov/owmitnet/mtb/sandfltr.pdf</a>

#### **Media Filters (TC-40)**

Media filters are usually two-chambered filtering structures consisting of a pretreatment settling basin and a filter bed filled with sand or other absorptive filtering media. Media filters are highly efficient at removing sediment, trash, metals, oil and grease and organic constituents; however, removal efficiencies are moderate for bacteria and low for nutrients. They are often used where the site precludes the use of surface BMPs.

For additional information regarding media filters.

http://www.cabmphandbooks.com/Documents/Municipal/TC-40.pdf or http://www.deq.state.id.us/water/data reports/storm water/catalog/sec 4/bmps/7.pdf

# Oil/Water Separators (TC-50)

Regional Water Quality Control Board Region 2 (August 5, 2004 Letter entitled "Use of storm drain inlet filters and oil/water separators to meet the requirements of NPDES Municipal Stormwater Permits"), indicates that vault based oil-water separators are generally ineffective at removing pollutants at concentrations seen in urban runoff. While their removal rates are low, the pollutants captured in one storm are likely to be flushed out in a subsequent storm. The Region 2 Board recommends that oil/water separators only be used as part of a treatment train and on projects where oil and grease concentrations are

expected to be very high. Oil and water separators are also commonly called water quality inlets or oil and grit separators.

For additional information oil/water separators. http://www.cabmphandbooks.com/Documents/Municipal/TC-50.pdf

#### **Catch Basin Inserts**

According to Regional Water Quality Control Board Region 2 (August 5, 2004 Letter) storm drain filters (also known as catch basin inserts) are discouraged because they are subject to clogging and binding, are rarely maintained, have rapidly decaying effectiveness rates over a time frame that is significantly shorter that the typically recommended replacement or maintenance intervals, are ineffective at removing dissolved pollutants, and are easily bypassed if fouled to prevent flooding.

### **Proprietary (Manufactured) Systems**

Proprietary systems are generally "end of pipe" treatment systems and are discouraged. Applicants are encouraged to research the BMP effectiveness based on independent studies.

For scientifically sound information to improve the design, selection and performance of BMPs. http://www.bmpdatabase.org/index.htm

# 7.3 Stormwater Pollutants

It is important that stormwater treatment control BMPs address the pollutants generated by the project. Review the tables in this section to eliminate unsuitable or incompatible treatment control measures from the list. As a treatment control BMP is eliminated, note the criteria that justified its removal on the checklist provided in Table 7-6. **Use this checklist during the development review process.** Table 7.1 provides a matrix of the categories of pollutants corresponding to various land uses.

Table 7-1: Pollutant Categories Associated with Various Types of Development

		Project Category						
GENERAL POLLUTANT CATEGORIES	SINGLE FAMILY RESIDENTIAL	MULTI-FAMILY RESIDENTIAL	COMMERCIAL/ INDUSTRIAL	AUTO REPAIR SHOPS	RESTAURANT	HILLSIDE DEVELOPMENTS	PARKING LOTS	STREETS/ROADS
Pathogens	Х	Р	P <sup>(3)</sup>		Х			
Metals				Х			Х	Х
Nutrients	Х	Х	P <sup>(1)</sup>			Х	P <sup>(1)</sup>	P <sup>(1)</sup>
Pesticides	Х	Х	P <sup>(1)</sup>			Х	P <sup>(2)</sup>	
Organic Compounds			P <sup>(2)</sup>	X <sup>(4)(5)</sup>				X <sup>(4)</sup>

Sediments	Х	Х	Х			Х	P <sup>(1)</sup>	Х
Trash & Debris	Х	Х	Х	Х	Х	Х	Х	Х
Oxygen Demanding Substances	Х	P <sup>(1)</sup>	P <sup>(1)</sup>		Х	Х	P <sup>(5)</sup>	P <sup>(5)</sup>
Hydrocarbons	Х	P <sup>(2)</sup>	Х	Х	Х	Х	Х	Х

Source: CASQA, 2003

X = Anticipated

P = Potential

- A potential pollutant if landscaping exists on-site.
   A potential pollutant if the project includes uncovered parking areas.
- A potential pollutant if land use involves food or animal waste products.
- Including petroleum hydrocarbons.
- Including solvents. (5)

Understanding the sources of pollutants associated with development is useful in selecting appropriate site, source and treatment control measures. The sources of pollutants commonly found in urban runoff are provided in Table 7-2.

Table 7-2: Sources of Pollutants Commonly Found in Urban Bunoff

	Table 7-2: Sources of Pollutants Commonly Found in Urban Runoff					
POLLUTANT	Major Sources	POTENTIAL EFFECTS				
Nutrients      • Nitrogen      • Phosphorus	<ul> <li>Fertilizers</li> <li>Animal Waste</li> <li>Detergents</li> <li>Atmospheric deposition</li> <li>Leaking sewage pipes</li> </ul>	<ul> <li>Lowers oxygen levels</li> <li>Destroys habitat</li> <li>Promotes algal blooms</li> <li>Limits recreation</li> <li>Interferes with navigation</li> </ul>				
Pathogens	<ul> <li>Animal waste</li> <li>Illicit connections between storm sewers and sewage lines</li> <li>Leaking sewage pipes</li> </ul>	<ul> <li>Poses human health risks</li> <li>Closes beaches</li> <li>Closes shellfish harvesting areas</li> </ul>				
Hydrocarbons  Oil Grease Petroleum-based products Polycyclic aromatic hydrocarbons (PAHs)	<ul> <li>Parking Lots</li> <li>Roads</li> <li>Automobile emissions</li> <li>Improper disposal of used motor oil</li> <li>Illicit connections to drain systems</li> </ul>	<ul> <li>Lowers levels of dissolved oxygen in receiving waters</li> <li>Causes toxic impacts</li> <li>Damages habitat</li> </ul>				
Toxic Organics	<ul> <li>Lawn care</li> <li>Agricultural lands</li> <li>Industrial uses</li> <li>Illicit connections to drain systems</li> </ul>	<ul> <li>Causes toxic impacts</li> <li>May lead to human and animal reproductive abnormalities</li> <li>Increases animal mortality rates</li> </ul>				
Sediments	<ul><li>Construction sites</li><li>Agricultural lands</li><li>Logged forest lands</li><li>Eroded stream banks</li></ul>	<ul> <li>Increases water turbidity</li> <li>Alters water flows</li> <li>Destroys benthic habitat</li> <li>Blocks sunlight</li> <li>Attracts particulate forms of metals and nutrients</li> </ul>				
Metals  • Lead  • Copper	<ul><li>Illicit connections to drain systems</li><li>Automobile emissions, Brake</li></ul>	<ul> <li>Increases toxicity of sediment and water column</li> </ul>				

POLLUTANT	Major Sources	POTENTIAL EFFECTS
<ul> <li>Cadmium</li> <li>Zinc</li> <li>Mercury</li> <li>Chromium</li> <li>Selenium</li> <li>Nickel</li> </ul>	pad residues	Adds toxins to food chain     Causes genetic defects, reproductive abnormalities and increased mortality rates among fish and wildlife     Increases risks of cancer, neurological disorders
Trash & Debris	Human activities	and birth defects among humans  • Aesthetic impacts • Impairs recreational uses • Threatens aquatic life
Elevated Temperatures	<ul> <li>Industrial sources</li> <li>Removal of trees next to streams and rivers</li> <li>Impervious surfaces and conveyances</li> </ul>	Threat to insects, fish and other temperature sensitive aquatic species

Sources: Terrene Institute, 1996; U.S. EPA, 1995

# 7.4 Treatment Control BMP Considerations

Site and land use categories can be used to further refine the list of suitable treatment controls.

#### **Effectiveness**

This category addresses how well the treatment control BMP is able to reduce the pollutants of concern in the stormwater. Eliminate treatment control BMPs that have a low effective removal rate for the pollutant of concern(s) associated with the project.

	POLLUTANT CATEGORY						
TREATMENT CONTROL BMPs	METALS	Nutrients	SEDIMENT	TRASH AND DEBRIS	OIL AND GREASE	Organics	PATHOGENS
Infiltration Trench (TC-10)	Н	Н	Н	Н	Н	Н	Н
Constructed Wetland (TC-21)	Н	М	Н	Н	Н	Н	Н
Retention Basin (TC-11)	Н	Н	Н	Н	Н	Н	Н
Detention Basin (TC-22)	М	L	М	Н	М	М	М
Vegetated Swale (TC-30)	М	L	М	М	М	М	L
Vegetated Filter Strips (TC-31)	Н	L	Н	М	Н	М	L

Bioretention (TC-32)	Н	М	Н	Н	Н	Н	Н
Surface Sand Filters	L	М	Н	L	Н	М	L
Media Filter (TC-40)	Н	L	Н	Н	Н	Н	М
Oil Water Separators (TC-50)	L	L	L	М	М	L	L
Catch Basin Inserts	L	L	L	М	L	L	L

L=Low, M=Medium, H=High

Source: xxxxxx

# **Probability of Failure**

Infiltration systems without adequate pre-treatment to remove sediment from runoff are at risk of premature failure due to clogging.

# **Proximity to Hot Spots**

Hot spots are areas that have higher concentrations of pollutants than is typically found in urban runoff. Treatment control facilities that discharge to groundwater should not be used at hot spot locations. Therefore, projects that generate hot spot type pollutants should not use infiltration trenches, retention basins, dry wells, permeable pavements with underground recharge beds.

## **Receiving Waters**

Projects discharging to Clean Water Act 303(d) listed water bodies must address all constituents that will contribute to the impairment of the water body.

#### Tributary Area

Some practices require a minimum area to ensure sufficient flows to the BMP, while others are limited to the maximum runoff they can handle. When considering the removal of a potential treatment control BMP based on tributary area, be sure to remember that large areas can be subdivided into smaller catchment areas to facilitate treatment or flow splitters that can be installed to capture and treat the first flush while by-passing larger storm events.

Additional information regarding flow splitters is available at the Minnesota Urban Small Sites BMP Handbook at:

http://www.metrocouncil.org/environment/Watershed/BMP/CH3 STFlowSplitters.pdf

Table 7-3 provides a list of treatment practices where effectiveness is based on the size of the tributary area draining to it.

Table 7-3. Applicability of treatment practices relative to BMP Tributary area

PRACTICE	FEASIBLE (ACRE)	Marginal (acre)
Infiltration Trench (TC-10)	0-5	5
Constructed Wetlands (TC-21)	25-100	10-25
Retention Basin (TC-11)	5 acre and/or base flow	5-10
Detention Basin (TC-22)	5-25	<5

Vegetated swales (TC-30)	0-5	5-50
Vegetated Filter Strips (TC-31)	0-5	5-10
Bioretention facilities (TC-32)	4-20	0.5-4 and 20-50
Surface Sand Filters	1-10	10-25
Media Filters (TC-40)	0-2	>2
Oil water separators (TC-50)	0-5	5-7.5

## Slopes

The slope of a BMP is a consideration in the Treatment Control BMP selection process. Larger BMPs, such as detention and retention basins, may require impractically large embankment heights if they were to be situated on a steep slope. Steep slopes may cause erosion or provide inadequate hydraulic residence times for vegetated strips and swales. When an entire site has steep slopes, it may be best to provide a number of smaller BMPs that can fit into the existing contours of the site.

# **Water Tables and Bedrock**

Treatment control BMPs that rely on the chemical, biological and physical properties of soil to achieve treatment goals may be limited due to high groundwater or shallow bedrock elevations.

#### **Available Land**

Densely developed sites may have inadequate space to incorporate some treatment control BMPs. Some treatment control BMPs require a significant amount of land for installation.

#### **Poorly Drained Soils**

Some treatment control BMPs, such as wetlands, thrive with poorly drained soils, while others treatment control BMPs are precluded for use unless under drains are incorporated into the treatment area.

#### **Grade Differences**

Most infiltration BMPs must be at a lower elevation than the adjacent areas from which they will receive runoff. Some filtering systems have modest head requirements that might preclude their use in some areas.

Table 7-4 provides a list of treatment practices that are influenced by the conditions listed above and that are typical of development sites.

**Table 7-4 Treatment Practices Site Condition Considerations** 

PRACTICE	HOT SPOT RUNOFF	STEEP SLOPES	HIGH WATER TABLE	SHALLOW BEDROCK	PROXIMITY TO FOUNDATION	POORLY DRAINED SOILS
Infiltration Trench (TC-10)	No	No	No	No	D	No
Constructed Wetland (TC-21)	Ok	Ok	Ok	D	Ok	No

Retention Basin (TC-11)	No	No	No	No	D	No
Detention Basin (TC-22)	D	No	No	No	D	Ok
Vegetated Swale/(TC-30)	D	D	No	Ok	D	D
Vegetated Filter Strips (TC-31)	No	No	No	No	No	Ok
Bioretention (TC-32)	D	Ok	No	No	D	Ok
Surface Sand Filter	Ok	No	No	No	No	No
Media Filter (TC-40)	Ok	Ok	Ok	Ok	Ok	Ok
Oil Water Separators (TC-50)	Ok	Ok	Ok	D	D	D
Catch Basin Inserts	Ok	Ok	Ok	Ok	Ok	Ok

Ok – compatible site conditions

#### Additional Considerations

There are additional considerations beyond the site considerations and targeted pollutant criteria described above, including cost, difficulty to maintain, community acceptance, habitat value and public safety.

#### Costs

The costs associated with initial construction and ongoing operation and maintenance (O&M) may influence the selection of one treatment control BMP over another.

#### Difficulty to Maintain

BMPs that are not properly maintained are ineffective.

#### Community Acceptance

Public understanding of a BMP's function is helpful in alleviating BMP concerns. BMPs that blend well into the existing landscape are generally favored over more structurally based BMPs.

### **Habitat Value**

Treatment control BMPs that improve habitat for aquatic, terrestrial and recreational uses, as well as address stormwater pollutants of concern are encouraged. Treatment control facilities may encourage adoption by endangered or threatened species—thereby eliminating the ability to perform routing operation and maintenance activities without benefit of environmental permits unless a "Safe Harbor Agreement" can be formalized in advance.

For additional information on safe harbor agreements.

http://www.mde.state.md.us/assets/document/wetlandswaterways/safeharbor.pdf

### Safety

BMP installations in areas frequented by community members, particularly children, such as parks, schools, or other recreation areas, should be selected with safety

No - Site condition that precludes treatment control BMP use

D - Site condition will require additional engineering to use treatment control BMP

concerns in mind. For areas where there is potential for the BMP to be disturbed or vandalized, consideration should be given to selecting a BMP that is less obvious and less likely damaged.

Table 7-5 provides a list of treatment practices ranked by the considerations mentioned in this section.

**Table 7-5 Other Considerations.** 

_	Соѕт		EASE OF	COMMUNITY	Навітат	_
PRACTICE	INITIAL	O&M	MAINTENANCE	ACCEPTANCE	VALUE	SAFETY
Infiltration Trench (TC-10)	Н	Н	Н	М	L	Н
Constructed Wetland (TC-21)	Н	М	M	Н	Н	М
Retention Basin (TC-11)	М	М	М	M	М	L
Detention Basin (TC-22)	L	L	L	L	L	М
Vegetated Swale (TC-30)	М	М	L	Н	Н	Н
Vegetated Filter Strips (TC-31)	L	L	L	М	L	Н
Bioretention (TC-32)	М	L	L	Н	М	Н
Surface Sand Filters	Н	М	М	М	L	Н
Media Filter (TC-40)	Н	М	L	L	L	Н
Oil Grit Separators (TC-50)	L	М	Н	М	L	Н
Catch Basin Inserts	L	М	М	М	L	Н

L – Low

Table 7-6 - Treatment Control Feasibility Checklist

TREATMENT CONTROL BMP	CONSIDERED FOR USE	REJECTED BASED ON
Infiltration Trench (TC-10)		
Constructed Wetland (TC-21)		
Retention Basin (TC-11)		

M – Medium

H - High

Detention Basin (TC-22)	
Vegetated Swale (TC-30)	
Vegetated Filter Strip (TC-31)	
Bioretention (TC-32)	
Surface Sand Filter	
Media Filter (TC-40)	
Oil & Water Separator (TC-50)	
Catch Basin Insert	
Proprietary Systems	

# Ch 8: Maintenance

# 8.1 Introduction to Stormwater Facility Maintenance

Stormwater facilities typically consist of a series of collection and conveyance systems, stormwater quantity control (detention/retention), and treatment facilities. A maintenance program is essential to ensure that the facilities continue to function as designed to maintain water quality and prevent possible flooding and property damage. To help understand stormwater facility maintenance requirements, it is useful to have a general knowledge of how they function.

# Collection and conveyance systems

Collection and conveyance systems intercept and transport stormwater. They typically consist of curb cuts or inlets that collect water and swales or pipes that move water. Stormwater conveyance systems are designed to accept a specific maximum flow rate, as determined by the runoff generated during the design storm and the tributary area to the facility.

Typical failures include reduced capacity due to clogged surface grates and pipes. Plugging commonly occurs due to sediment and large debris washed from adjacent surfaces. Reduced conveyance system capacity results in localized flooding and possible property damage.

# **Quantity Control (detention/retention)**

The intent of stormwater quantity control facilities is to reduce the peak flow and/or volume discharged from developed sites.

Detention facilities mitigate the site's increased runoff rate by providing temporary storage and controlling the release rate from the site through the use of orifice plates. The intent of the detention basin is to match the pre-developed runoff rates for several specific storm events in the developed condition (i.e. store the volume associated with the 50-year storm under developed conditions and release it at the 2-year pre-developed discharge rate). The runoff leaving the basin is metered from the basin to reduce potential stormwater impacts to surface waters or pipe networks located downstream of the development. While some detention facilities are able to reduce the volume of runoff released, they mainly serve to control the release rate of storms.

Retention facilities do not discharge to pipes or surface water bodies, rather they provide temporary storage until the collected runoff is able to soak into the ground.

Detention and retention facilities may be designed as basins or as underground facilities.

When infiltration devices fail, it is usually as a result of:

- 1. An inaccurate estimation of the Design Infiltration Rate;
- 2. An inaccurate estimation of the seasonal high water table;
- 3. Excessive compacting or sediment loading during construction;
- 4. No pretreatment for post-development and lack of maintenance.

#### Treatment facilities

Treatment facilities seek to remove oils, chemicals, metals, and sediment from stormwater runoff prior to being discharged from the property. They achieve this goal through a combination of filtration, sediment settling, plant nutrient uptake and physical separation and may consist of landscape and structural components.

Typical failures are dependent on the type of treatment facility specified. Facilities that are underground or difficult to access are at greater risk of neglect due to the "out of site, out of mind" factor. Passive, surface types of treatment facilities are generally considered easier to identify and address small problems before they become big problems.

Each of these types of facilities requires ongoing operational and maintenance activities to be done to ensure they continue to meet the purpose for which they were installed.

This chapter provides insight into the maintenance requirements for each types of facility, although multiple types of facilities may be present at each site. Some maintenance needs are common to all types of facilities, while others depend on the specific facility.

Example maintenance checklists are provided for the common types of stormwater facilities used in San Luis Obispo County shown in the list below.

Infiltration Trench (TC-10)
Retention Basin (TC-11)
Vegetated Swale (TC-30)
Bioretention (TC-32)
Media Filter (TC-40)
Catch Basin Insert

Wetlands (TC-21)
Detention Basin (TC-22)
Vegetated Filter Strip (TC-31)
Surface Sand Filter
Oil & Water Separator (TC-50)
Proprietary System

Facility owners should incorporate the use of maintenance procedures and checklists that apply to their facilities into their Operation and Maintenance Plans. Structural or treatment control BMPs located within a public area proposed for transfer will be the responsibility of the developer until they are accepted for transfer by the County or other appropriate public agency.

# 8.2 Operation and Maintenance (O&M) Plans

Private stormwater facility owners are responsible for ensuring that the facilities are maintained and continue to function as designed. As part of the project application, the property owner shall complete an O&M maintenance agreement. The private stormwater facility owner will draft an O&M Plan and will provide a self-certification statement ensuring compliance with the Plan.

The Operation and Maintenance (O&M) plan must:

- Identify who is responsible for maintenance and how the maintenance will be funded. A copy of the maintenance agreement must be included with the O&M Plan.
- Include an overview of site drainage patterns, including all discharge points and the location of each treatment BMP.
- Document design parameters, features, methods and materials of construction, intended mode of operation and other key characteristics of stormwater treatment BMPs on the site.
- Include BMP manufacture data and handbooks for proprietary BMP systems.

- Identify the maintenance program and schedule to ensure treatment BMPs continue to operate as intended. Maintenance is required at least once per year.
- A checklist to be used during verification inspections.

The O&M Plan and self-certification must be filed as a covenant to the recorded deeds for all lots to enforce the imposition of any special tax assessment that may be necessary to maintain stormwater treatment facilities if the responsibility party fails or is unable to perform any of the obligations in the Maintenance Agreement.

# 8.3 Transferring O&M Responsibility for Stormwater Facilities

There are two ways to transfer O&M responsibilities:

- Structural or treatment control BMPs located within a public area proposed for transfer will be the responsibility of the developer until they are accepted for transfer by the County or other appropriate public agency.
- The responsibility of private ownership of stormwater facilities can also be transferred to another private entity when the property is sold, transferred, or leased to another person or entity by including O&M responsibility as a condition in the sales, transfer or lease agreement. The first deed transfer or any lease agreements shall include the details of these requirements and information about the BMP such as the following:
  - BMP location;
  - o How and when to perform the necessary inspections and maintenance; and
  - How long to keep all inspection and maintenance records.

The transfer of this information is required with any subsequent sale of the property.

# 8.4 Example Stormwater BMP Maintenance and Inspection Checklists

# **Example Maintenance Checklist for Infiltration Trench BMP (TC-10)**

	ROUTINE MAINTENANCE ACTIVITIES FOR INFILTRATION TRENCHES		
No.	Maintenance Task	FREQUENCY OF TASK	
1	Remove obstructions, debris and trash from infiltration trench and dispose of properly.	Monthly, or as needed after storm events	
2	Inspect trench to ensure that it drains between storms, and within 5 days after rainfall. Check observation well 2-3 days after storm to confirm drainage.	Monthly during wet season, or as needed after storm events	
3	Inspect filter fabric for sediment deposits by removing a small section of the top layer.	Annually	
4	Monitor observation well to confirm that trench has drained during dry season.	Annually, during dry season	
5	Mow and trim vegetation around the trench to maintain a neat and orderly appearance.	As needed	
6	Remove any trash, grass clippings and other debris from the trench perimeter and dispose of properly.	As needed	
7	Check for erosion at inflow or overflow structures.	As needed	
8	Confirm that cap of observation well is sealed.	At every inspection	
9	Inspect infiltration trench using the Trench inspection checklist.	Monthly, or after large storm events, and after removal of accumulated debris or material	

#### Prohibitions:

Trees and other large vegetation should be prevented from growing adjacent to the trench to prevent damage. Standing water shall not remain in the trench for more than three days, to prevent mosquito generation. Should any mosquito issues arise, consult the County Health Department for proper vector control measures.

### **Example Maintenance Checklist for Detention Basin BMP (TC-22)**

	Routine Maintenance Activities for Extended Detention Basins		
No.	Maintenance Task	Frequency of Task	
1	Conduct annual vegetation management during the summer, removing weeds and harvesting vegetation. Remove all grass cuttings and other green waste.	Once a year	
2	Trim vegetation at beginning and end of wet season to prevent establishment of woody vegetation, and for aesthetics and mosquito control.	Twice a year (spring and fall)	
3	Evaluate health of vegetation and remove and replace any dead or dying plants. Remove all green waste and dispose of properly.	Twice a year	
4	If turf grass is included in basin design, conduct regular mowing and remove all grass cuttings. Avoid producing ruts when mowing.	As needed	
5	Remove sediment from fore bay when the sediment level reaches the level shown on the fixed vertical sediment marker and dispose of sediment properly.	As needed	
6	Remove accumulated sediment and regrade when the accumulated sediment volume exceeds 10% of basin volume and dispose of sediment properly.	Every 10 years, or as needed	
7	Remove accumulated trash and debris from the extended detention basin at the middle and end of the wet season and dispose of trash and debris properly.	Twice a year (Before and after the rainy season)	
8	Inspect extended detention basin using the attached inspection checklist.	Quarterly, or as needed	

# Prohibitions:

The use of pesticides and quick release fertilizers shall be minimized, and the principles of integrated pest management (IPM) followed.

**Example Wetland and Basin BMP Inspection Checklist** 

Example Wetland and Basin BMP Inspection Checklist		
Inspection Items	Satisfactory (S) or Unsatisfactory (U)	Comments/Corrective Action
General		
Dead, diseased, or dying vegetation present?		
Poisonous vegetation, noxious weeds or excessive weeds present?		
Does tree growth interfere with required maintenance activities?		
Any evidence of oil, gasoline, contaminants or other pollutants?		
Is vegetation sparse or are there bare or eroded patches occurring in more than 10% of the swale bottom or 30% of swale side slopes?		
Embankment and Emergency Spillway		
Any evidence of rodent holes if facility is acting as a dam or berm?		
Is erosion damage within basin over 2 inches deep with the cause of damage or potential for continued erosion still present?		
Is erosion present in/around emergency spillway?		
Cracking, sliding, bulging of embankment or spillway? Any part of berm settled 4 or more inches lower than the design elevation?		
Any discernable water flow through embankments?		
Any obstructions of spillway(s)?		
Inlet/Outlet Structures and Channels		
Clear of debris and functional?		
Accumulated sedimentation in fore bay or inlet structure?		
For concrete structures, any cracks wider than 1/2-inch and longer than 1-foot with evidence of soil particles entering the structure through the cracks?		
Pipes, plates in good condition?		
Outfall channels functional and not eroding?		
Basin Bottom		_
Accumulated sedimentation?		
Hazards		
Have there been complaints from residents or public hazards notes?		

# **Example Maintenance Checklist for Vegetated Swale BMP (TC-30)**

	Routine Maintenance Activities for Vegetated Swales		
No.	Maintenance Task	Frequency of Task	
1	Mow turf grass	As needed	
2	Remove obstructions and trash from vegetated swale.	Monthly, or as needed	
3	Inspect swale to check for erosion and sediment and debris accumulation and dispose of sediment and debris properly.	Twice a year: 1) one inspection should occur at the end of the wet season in order to plan and schedule summer maintenance, 2) the other inspection should occur after periods of heavy runoff	
4	Remove sediment accumulating near culverts and in channels and dispose of sediment properly.	As needed.	
5	Inspect swale using the inspection checklist.	As needed	

#### Prohibitions:

The use of pesticides and quick release fertilizers shall be minimized, and the principles of integrated pest management (IPM) followed.

**Example Maintenance Checklist for Vegetated Filter Strip BMP (TC-31)** 

Example Maintenance Checkinst for Vegetated Filter Strip BMF (1C-31)		
Routine Maintenance Activities for Vegetated Buffer Strips		
No.	Maintenance Task	Frequency of Task
1	Mow turf grass remove grass cuttings.	As needed
2	Remove obstructions and trash from vegetated buffer strip and dispose of properly.	Monthly, or as needed
3	Inspect buffer strip to check for erosion and sediment and debris accumulation. Dispose of sediment and debris properly.	Twice a year: 1) one inspection at the end of the wet season in order to plan and schedule summer maintenance, 2) the other inspection after periods of heavy runoff
4	Remove sediment accumulating near culverts and if it covers vegetation. Dispose of sediment properly.	As needed
5	Inspect buffer strip using the inspection checklist.	As needed

# Prohibitions:

The use of pesticides and quick release fertilizers shall be minimized, and the principles of integrated pest management (IPM) followed.

# **Example Maintenance Checklist for Bioretention BMP (TC-32)**

Routine Maintenance Activities for Bioretention Areas		
No.	Maintenance Task	Frequency of Task
1	Remove obstructions, debris and trash from bioretention area and dispose of properly.	Monthly, or as needed after storm events
2	Inspect bioretention area to ensure that it drains between storms and within five days after rainfall.	Monthly, or as needed after storm events
3	Inspect inlets for channels, soil exposure or other evidence of erosion. Clear obstructions and remove sediment.	Monthly, or as needed after storm events
4	Remove and replace all dead and diseased vegetation.	Twice a year
5	Maintain vegetation and the irrigation system. Prune and weed to keep bioretention area neat and orderly in appearance.	Before wet season begins, or as needed
6	Check that mulch is at appropriate depth (3 inches per soil specifications) and replenish as necessary before wet season begins.	Monthly
7	Inspect bioretention area using the attached inspection checklist.	Monthly, or after large storm events, and after removal of accumulated debris or material

#### Prohibitions:

The use of pesticides and quick release fertilizers shall be minimized, and the principles of integrated pest management (IPM) followed.

#### **Example Maintenance Inspection Checklist for Bioretention BMP Facilities**

Example Maintenance inspection Checkist for Bioretention BMF Facilities		
Inspection Activities	Suggested Schedule	
Inspect for: trash and debris; yard waste, excessive erosion; sediment accumulation in the basin; tree growth on overflow structure; the presence of burrowing animals; standing water where there should be none; vigor and density of the grass turf. Note signs of pollution, such as oil sheens, discolored water, or unpleasant odors.	Annually	
Maintenance Activities	Suggested Schedule	
Clean and remove debris from bioretention area and contributing areas Mow Prune and weed planted areas.	Monthly or as needed	

#### **Proprietary Treatment Systems**

Manufactured Stormwater Treatment Measures are proprietary treatment devices that tend to be installed below ground and operate using some type of proprietary filter media, hydrodynamic separation, or sedimentation and screening. Common examples of manufactured treatment measures include manufactured media filters, inlet filters or drain inserts, oil/water separators and hydrodynamic separators.

#### Routine Maintenance Activities

The principal maintenance objective is to prevent sediment buildup and clogging, which reduces pollutant removal efficiency and may lead to failure of the manufactured treatment measure.

# **Example Maintenance Checklist for Proprietary System BMPs**

Routine Maintenance Activities for Manufactured Treatment Measures		
No.	Maintenance Task	Frequency of Task
1	Inspect for standing water, sediment, trash and debris.	Monthly during rainy season
2	Remove sediment, trash and debris from sedimentation basin, riser pipe and filter bed, using vactor truck method. Dispose of sediment, trash, filters and debris properly.	As needed
3	Ensure that manufactured treatment measure drains completely within three days.	After major storm events and as needed.
4	Inspect outlets to ensure proper drainage.	Monthly during rainy season, or as needed after storm events
5	Follow manufacturer's guidelines for maintenance and cartridge replacement.	As per manufacturer's specifications.
6	Inspect manufactured treatment measure, using the attached inspection checklist.	Monthly, or after large storm events, and after removal of accumulated debris or material

# Prohibitions:

Trees and other large vegetation shall be prevented from growing adjacent to the manufactured treatment measure to prevent damage. Standing water shall not remain in the treatment measures for more than three days, to prevent mosquito generation.